MACHINERY.

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VARIABLE SPEED MOTORS.—11.

THE THOMPSON-RYAN VARIABLE SPEED MOTOR.

WM. BAXTER, JR.

In previous articles of this series we have shown that there are two difficulties that stand in the way of obtaining unlimited variation in the velocity of a motor. One of these is that the size of the machine increases as the range of speed increases, and the other that the difficulty of obtaining sparkless operation of the commutator brushes increases with the range of variation. In many cases the advantages derived from a speed

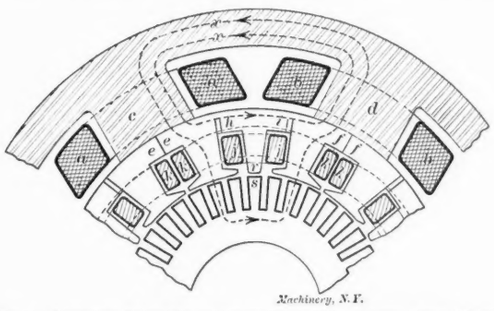


Fig. 1. Showing Principle of Operation of Thompson-Ryan Motor.

variation of, say, ten to one, might be so great as to make it advisable to use a motor ten times as large as would be required for the higher velocity. If we undertake to accomplish this result with a two-wire system, that is, with a single voltage, we will find that it is not practical by the ordinary methods, even if we are willing to use a motor of the necessary size. The reason why it is not practical is that long before any such wide variation is obtained the sparking of the brushes will be so severe as to make the successful running of the motor impossible.

Fig. 3. View of the Field with Balancing Ring in Position.

The reason why the sparking of the brushes prevents the attainment of a great change in velocity with a single voltage is that the change is obtained by reducing the strength of the field magnetism. The field magnetism, and the magnetism induced by the current flowing through the armature coils, are at right angles to each other, and a torsional force is set up between them. If the field magnetism is strong and that of the armature is weak, the former will not be drawn very far away from its natural position. If, however, the field magnetism is weak and that of the armature is very strong, the latter will predominate and as a result the field will be twisted around quite an angle from its natural position.

To secure sparkless running of the commutator brushes it is necessary that the armature coils connected with the segments passing under the brushes move through a magnetic field just strong enough to develop an E.M.F. sufficient to reverse the current in the coil and build up a current of the same strength flowing in the opposite direction, during the time the coils are short-circuited by the brushes. Such a field can be found at a point between the poles of the motor for a particular strength of field and armature current; but any variation in the strength of the motor field or the armature current will change the strength of the field at this point and cause sparking at the brushes. If the field remains unchanged, and the armature current varies, the field at the

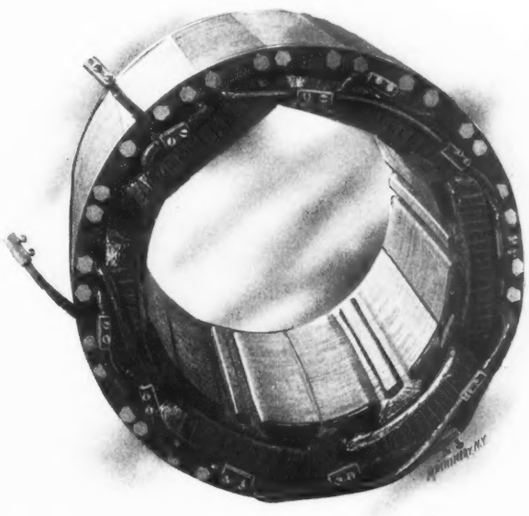


Fig. 2. Balancing Ring.

commutation point will vary directly through the change in the strength of the field developed by the armature current, and indirectly through the variation in the extent to which the field magnetism is diverted from its natural position. If the strength of the field magnetism is varied, the commutation field will be varied in consequence of the change in the angle through which the field magnetism is distorted by the reaction of the armature.

If the strength of the armature current is not varied too much, or if the strength of the motor field is changed but slightly, the effect upon the action of the commutator brushes will be so small that it will not be noticeable; but anything more than a slight change will so increase the sparking of the brushes as to render the operation of the motor unsatisfactory.

How to Obtain Sparkless Commutation.

To obtain sparkless operation of the brushes, when the armature current and the field strength are varied through wide limits, it is necessary to provide means to entirely neutralize the distorting effect of the armature current upon the field magnetism, so that the direction of the latter may always re-

main the same, regardless of its strength; and further to provide a commutating field that is independent of the motor field and that will increase and decrease as the strength of the armature current increases and decreases. This result is fully accomplished in the Thompson-Ryan motor made by the Ridgway Dynamo & Engine Co., Ridgway, Pa. It is built upon the same principle as their generators, which have been in successful operation for many years.

Principle of Operation of the Thompson-Ryan Motor.

The principle of operation of this motor can be fully understood from the sketch, Fig. 1, which shows a portion of the field and armature and of a ring carrying some magnetizing coils, called a balancing ring, which is placed between the field and armature. The outer ring, shaded with section lines, is the field; *c* and *d* are the polar projections upon which the field magnetizing coils *aa*, *bb*, are placed, these being connected in shunt relation to the armature. The balancing ring is made up of sheet steel laminations, *h i r* and *e e*, *f f*. The latter named pieces form extensions of the polar cores *c* and *d*. A coil, *j j*, is placed around the small polar core, *r*, and another coil, *k k*, of larger size embraces one of the *e* and one of the *f* cores. Both these coils, *j j* and *k k*, are connected in series with the armature, so that the current passing through them at all times is equal to that passing through the armature, being the same current. The coils, *k k*, are so connected with the circuit that the current flows through them in the opposite direction to that flowing through the armature conductors im-

Fig. 4. Showing Motor Complete.

mediately under them. Hence, the magnetizing action of the coils is directly opposed to that of the armature, and as they are properly proportioned to exactly balance the armature coils the effect is that the reaction of the armature upon the field is entirely neutralized, so that the path of the field magnetism is always that indicated by the lines, *x x*, no matter how weak the field may be.

Action of the Coil J J.

The coil, *j j*, wound upon the core, *r*, develops a magnetic flux that passes through *s* and forms the commutating field. This coil, *j j*, is connected in series with *k k* and with the armature, hence, the magnetic flux developed by it rises and falls with the rise and fall of the armature current. This is just what is wanted to secure perfect commutation; for if the armature current is weak, the E.M.F. induced in the commutated coil must be small so as to not develop a current too strong; and, as the armature current increases, the E.M.F. induced in the commutated coil must increase, so that the commutating current may not be too weak. In theory it is possible to obtain perfect commutation by means of these balancing coils, provided the magnetization of the iron cores is not carried too high. In practice the degree of perfection attained depends wholly upon the accuracy with which the various parts are proportioned.

The actual appearance of the balancing ring is shown in Fig. 2. Fig. 3 shows the field with the balancing ring in position.

Effect of Balancing Ring on Size of Motor.

It might be supposed that the introduction of this balancing ring between the field and armature of the motor would result in materially increasing the size of the machine. Such, however, is not the case, as can be seen from Fig. 4, which shows a 7½ H. P. motor designed for a speed variation of six to one. Considering the range of velocities the size is not excessive.

The Thompson-Ryan Drum Type Controller.

The Ridgway Company make a drum controller for the operation of these motors. This controller is made either reversing or non-reversing. In addition to the contacts necessary

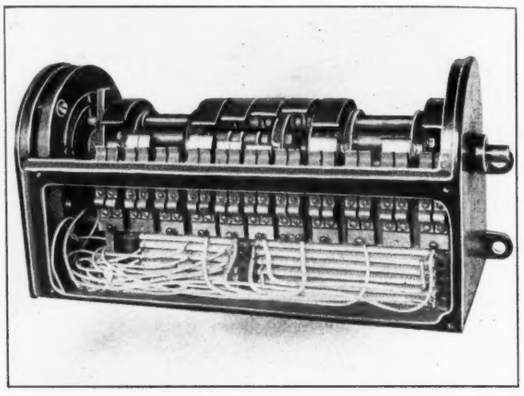


Fig. 5. Controller with the Casing Removed.

for connecting the motor with the circuit and for varying the speed, it has other contacts that are used to effect a quick stop whenever such is required. These contacts connect the armature in a closed circuit in which more or less of the starting resistance is included, after the connection with the line is broken; and thereby convert the motor into a generator for the time being, thus producing a dynamic brake effect. The controller, with the casing removed, is shown in Fig. 5. A row of stationary contacts connects with the rings mounted upon the drum, as the latter is rotated, and thus makes the necessary connections between the motor and the line to produce rotation in the desired direction and also to cut out the starting resistance from the armature circuit. At one end of the controller box are secured, in two circular rows, contacts that connect with the resistance that is introduced into the shunt field circuit of the motor to obtain the required increase in speed. The drum carries a pair of contacts connected with each other, but insulated from other parts, that ride over the field resistance contacts and thus cut in the sections of the latter.

Operation of the Controller.

The connections of the controller, and those between it, the motor and the line are well shown in the wiring diagram, Fig.

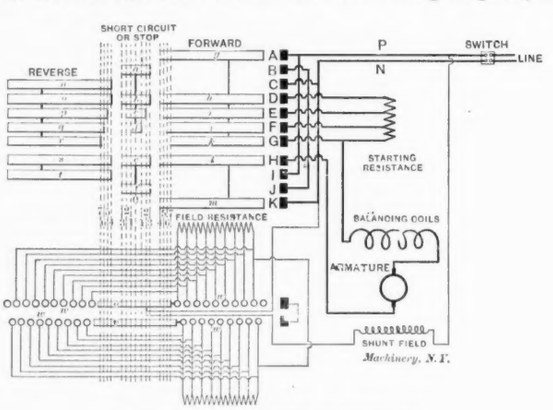


Fig. 6. Wiring Diagram of Controller.

6. This diagram also shows the way in which the balancing coils of the motor are connected in the armature circuit.

The stationary contacts, *A B C* to *K*, rest along the line *O* when the motor is stopped, and so do the two *L* contacts that cut in the field resistance; that is, these rest on *u* and *v* along the line *O*. The first three steps of the controller do not con-

nect the motor with the line; these are used only in stopping and are provided so as to cut in all or only a portion of the starting resistance, according to the rapidity with which it is desired to stop. In starting the motor the operation is as follows:

Suppose it is desired to run in the forward direction, then the controller is turned to the right to the fourth step, and this movement will slide ring g under contact A, ring h under contact D, ring l under contact H and ring m under contact K. As rings g and h are connected with each other, the current from line wire P will pass to D and thence through all the starting resistance to the balancing coils, through the latter to the armature, and through this to contact H. As H rests on l, and the latter is connected with m, the current passes to K and thence to line N. The current for the shunt field of the motor passes from line N to and through the field coils to contact v, and as this contact is connected with u through the two contacts L the current can find its way to line N just beyond contact K. When the controller is advanced to the fifth step drum ring i slides under contact E, and thus one section of the starting resistance is cut out. On the sixth step, drum ring j slides under contact F, thus cutting out the second section of the starting resistance. On the seventh step ring k connects with contact G and all the starting resistance is cut out.

Further advance of the controller slides the two contacts L over the contacts w and thus the field resistance is cut in and the speed is increased until the maximum velocity is reached.

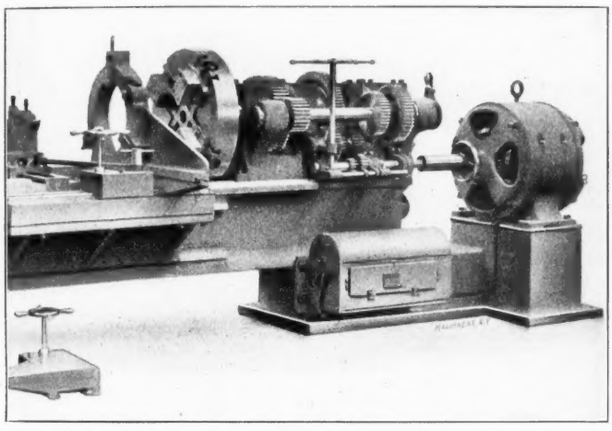


Fig. 7. Lathe Driven by a Thompson-Ryan Motor, showing Method of Connection.

On the seventh step the motor runs at its lowest velocity, 19 other speeds are obtained between this and the maximum velocity.

In stopping, if it is desired to make a slow stop, the controller is returned to a position between the fourth and the third steps. In this position the motor is entirely disconnected from the line. If a quick stop is desired, the controller is brought back to the third step and then drums contacts a and b connect stationary contacts B and D, while drum contacts e and f connect stationary contacts H and J. By tracing the circuit from B it will be found that it is to D, thence through the whole of the starting resistance to the balancing coils, through the latter and the armature to H and then to J and back to B. If the controller is moved back to the second step, B D and E will be connected by a b and c, so that one section of the starting resistance will be cut out. This will reduce the resistance against which the armature will have to generate a current; hence, the current will be stronger and the retarding effect greater. If the controller is returned to the first step, two sections of the starting resistance will be cut out and as a result the current generated by the armature will be still stronger, thus producing a still quicker stop.

The way in which the Thompson-Ryan motors are connected with machine tools is illustrated in Fig. 7, which shows one of these motors of 15 H. P. with a speed range from 350 to 1,750 connected with a 27-inch by 14-foot projectile-turning lathe, of Lodge & Shipley make.

NOTES ON RIVETED JOINTS.

WALTER RAUTENSTRAUCH.

In "Special Topics on the Design of Machine Elements," by Prof. John H. Barr, we find the following equations concerning riveted joints:

$$d = \frac{4}{\pi} \times \frac{n\,k_1 f_s + m\,k_2 f_s^1}{n\,f_s + 2\,m\,f_s^1}\,t$$

and

$$p = \frac{\pi}{4} d^2 \left(\frac{n\,f_s + 2\,m\,f_s^1}{t\,f_t} \right) + d$$

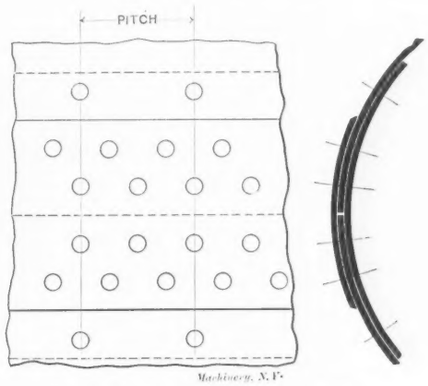
where

t = thickness of plate
d = diameter of rivet
p = pitch of rivet

} for maximum efficiency.

n = number of rivets in single shear per unit strip of joint.
m = number of rivets in double shear per unit strip of joint.
f_s = intensity of shearing stress in single shear rivets.
f_s^1 = intensity of shearing stress in double shear rivets.
f_t = intensity of tensile stress.
$k_1 = \frac{f_b}{f_s}$ where f_b = intensity of crushing stress in single shear rivets.
$k_2 = \frac{f_b^1}{f_s^1}$ where f_b^1 = intensity of crushing stress in double shear rivets.

It can readily be seen from the above equations that the diameter of rivet and also the pitch may be found when the form of the joint and the thickness of the plate are known.



Type of Joint used in the Calculations.

The form of the joint can easily be determined for any case by comparison with those which usually exist in practice.

The thickness of the plate may be found as follows:

Let P = pressure in pounds per square inch.
D = diameter of boiler in inches, then

$$t = \frac{P\,D}{2\,E\,f_t}$$

where E = efficiency of joint.

In the same text cited above Prof. Barr gives the general expression for the efficiency of any joint whatever, as,

$$E = \frac{1}{1 + \dfrac{f_t}{n\,k_1 f_s + m\,k_2 f_s^1}}$$

which may be transformed to

$$E = \frac{n\,f_b + m\,f_b^1}{n\,f_b + m\,f_b^1 + f_t}$$

This expresses the efficiency for equality of shearing, crushing and tearing strengths.

Substituting the value of E thus found in the equation for the thickness, we have

$$t = \frac{P\,D\,(n\,f_b + m\,f_b^1 + f_t)}{2\,(n\,f_b + m\,f_b^1)\,f_t}$$

If there are no rivets in double shear, the equation becomes

$$t = \frac{P\,D\,(n\,f_b + f_t)}{2\,n\,f_b\,f_t}$$

and if there are none in single shear it becomes

$$t = \frac{P\,D\,(m\,f'_b + f_t)}{2\,m\,f'_b\,f_t}$$

Thus for any joint whatever, whether the rivets are in single or double shear, or both, when the form of joint is decided upon, the thickness of plate can be determined. Then by substituting the value found for the thickness, and by introducing the proper value for the other members of the equations for pitch and diameter of rivets—these values depending on the form of joint—the pitch and diameter of rivet may be found.

To illustrate, let it be proposed to design the longitudinal seam of a boiler whose diameter is 60 inches and which is to carry a pressure of 200 pounds per square inch. The first step will be to decide on the form of the joint. Let it be a double riveted butt joint with an inside cover plate, having 4 rivets per unit strip in double shear and 1 rivet in single shear, as shown in the figure.

Let $f_b = 60{,}000.$	$f_s = 36{,}000.$
$f'_b = 72{,}000.$	$f'_s = 32{,}000.$
$f_t = 50{,}000.$	factor of safety $= 5.$

Substituting in the equation for thickness of plate, we have

$$t = \frac{200 \times 60\ (60{,}000 + 288{,}000 + 50{,}000)}{2\ (60{,}000 + 288{,}000)\ 50{,}000} \times 5 = .68'' = \tfrac{11}{16}''$$

and in the equation for diameter of rivet we have

$$d = \frac{4}{\pi} \times \left(\frac{1.66 \times 36{,}000 + 4 \times 2.25 \times 32{,}000}{36{,}000 + 8 \times 32{,}000}\right) \times .68 = 1''$$

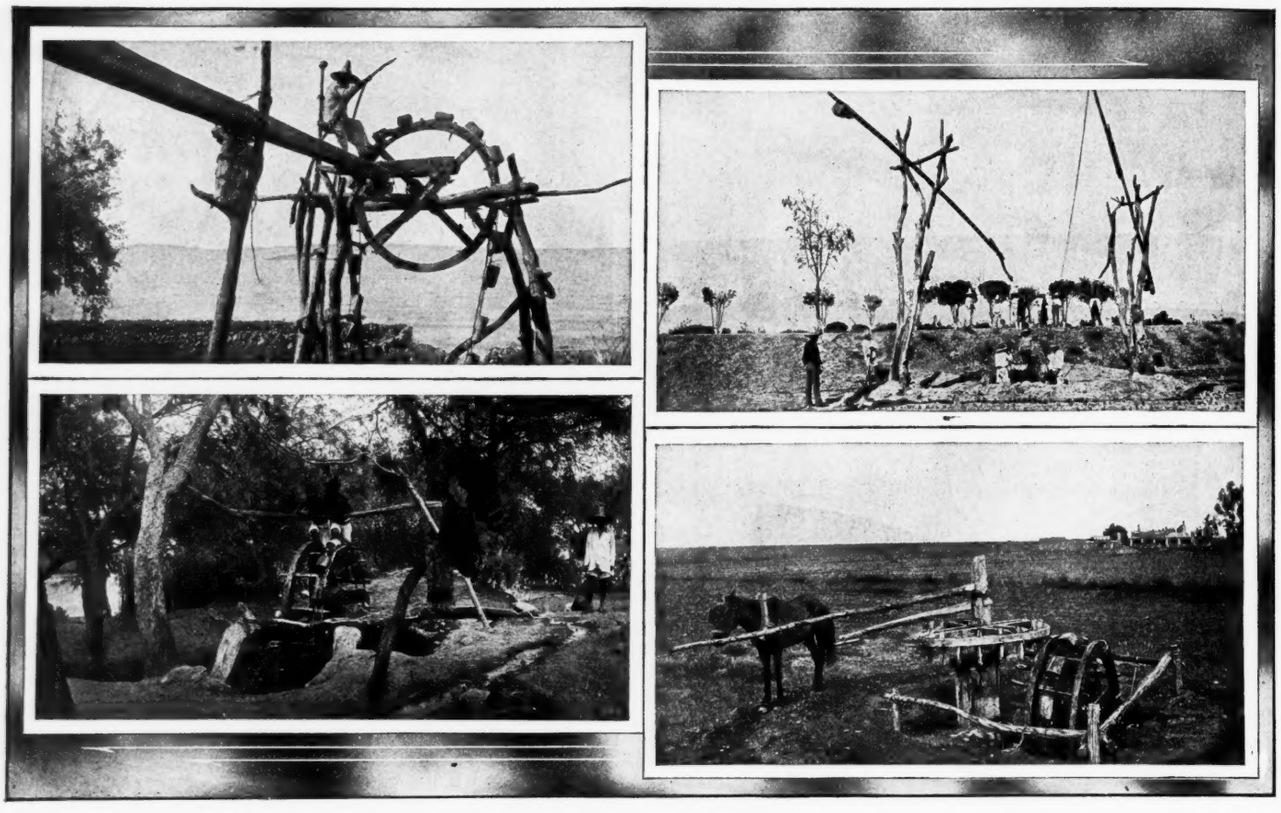
and for pitch of rivet, we have

$$p = \frac{\pi}{4}\left(\frac{36{,}000 + 8 \times 32{,}000}{.68 \times 50{,}000}\right) + 1 = 7\tfrac{5}{8}''$$

The above is to be understood as applying only to the design of joints for maximum efficiency, *i. e.*, when the efficiencies in shearing, crushing and tearing are all equal. The values of *t*, *d*, and *P*, given above, were derived by equating the strength in shearing, crushing and tearing.

PUMPING IN MEXICO.

The accompanying photographs, loaned to us by Henry R. Worthington, 114 Liberty Street, New York City, were taken in Southern Mexico, and show the methods in general use there for elevating water. The patents on these devices have doubtless long since expired and we feel, therefore, perfectly safe in giving them out to the public. The Worthington Company write, "We might add that it is to be observed, in the way of comparisons, that one of the man-and-wheel pumps seems to develop a very much higher duty than the other, from the fact that, whereas in one case a single man keeps the thing going with his 'shirt on,' in the other case two men without shirts, or much of any other clothing to speak of, are required. The dreams of these 'high-drawlick' engineers are certainly never troubled by visions of that Old Man of the Sea of the modern engineer, the question of fuel consumption."



Pumping by Ancient Methods in Mexico.

It is interesting to know that these ancient devices are being rapidly replaced by more effective machines of modern type and that Worthington irrigation pumps of the new turbine pattern are coming into very extensive use in Mexico, where power is cheaply developed by utilizing the many mountain streams for generating electric current, and then distributing it over the vast agricultural areas lying between the mountain chains.

* * *

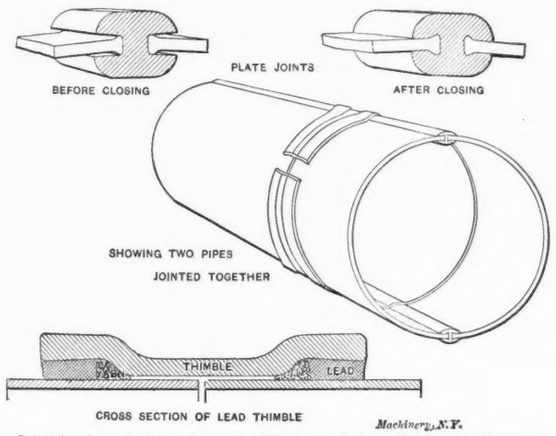
There have been a number of very interesting experiments carried on recently to ascertain the relative economy of the different sizes of coal used on locomotives. These were made in a so-called Wooten firebox and proved conclusively that even with this size grate the larger coal was more economical. This is rather hard on the advocates of the alleged "dirt burners" which were destined to revolutionize the railroad field a few years ago, if their stories were to be believed. Tested in a firebox better suited to its needs the larger coal will make a much better showing and bear out the contentions of those who have always claimed that the economy of the dirt burners was imaginary and in reality existed on the other side of the ledger. These go to prove that some of the fads of design and practice in railroading are likely to be short-lived if the managers are really after the most economical operation of the roads.

CONSTRUCTION OF THE COOLGARDIE PIPE LINE.

A remarkable engineering feat has been performed in Australia, of which the world has heard very little, and that is the carrying of a pipe line from the western coast to the Coolgardie gold fields, a distance of 363 miles in direct line from the port of Fremantle. Gold was discovered in this region in 1892, but the great scarcity of water made working of the mines practically impossible, the average rainfall being only slightly over 7 inches, and the climate being almost tropical in summer. It was first attempted to obtain water by boring, but after wells over 3,000 feet deep had been driven through granite without finding water in paying quantities, the attempt was given up. It was then proposed to carry a pipe line from the coast and this scheme was finally adopted in 1895. The enormous cost of the project, principally due to the large amount of pipe required, made the design of the pipe itself one of the first importance. Its diameter is 30 inches, and it is made of steel boiler plate in sections 28 feet in length. It was required to stand a hydraulic test of 400 pounds per square inch, and it is clear that the design of longitudinal joint which most nearly approached in strength that of the solid plate would be the most advantageous, other things being equal.

After a series of tests, the construction embodying the Mephan-Ferguson locking-bar joint was selected. This remarkably simple construction makes the joint of practically 100 per cent efficiency, that is, the joint is as strong or even stronger than the solid plate itself. With this joint it was possible to make the pipes of steel plate only ¼ inch thick, save in some portions of the line, as at the bottom of deep valleys where heavier pressures existed, and in these parts the pipes were made of plates 5-16 inch thick, but even with pipes of the average thickness of only ¼ inch, the total estimated weight of steel plate required for the line is something like 76,000 tons.

As will be seen from the accompanying illustration, each



Joint for Longitudinal Seams of Pipe, having an Efficiency of nearly 100 per cent.

pipe is made up of two steel plates rolled into semi-circular form, the edges of the plates being upset by a special upsetting press, and then the locking-bar is forced on, appearing as shown in the view designated "before closing." The sides of the locking-bar are then closed upon the sheets by powerful hydraulic machinery, making a hermetically sealed joint, which, as stated, is as strong or stronger than the solid plate. This type of joint has the additional advantage over riveted joints that there are no rivet heads projecting into the interior of the pipe to retard the flow; the locking-bars being arranged longitudinally offer practically no retarding effect to the flow, save the reduction in cross section which is very slight. The connection between the pipe ends is formed in essentially the same manner as is ordinarily employed with cast-iron water pipes. It is composed of a forged steel sleeve, bell-mouthed at the ends as shown in the cross section. A soft packing of yarn or oakum is first rammed in, and then lead is poured and calked in place by a hydraulic press. To preserve the pipe line from corrosion, each pipe was immersed in a bath of hot asphalt, and kept there until the steel had attained the same temperature as the bath. There are twenty pumping stations distributed along the line. It is worthy of note that one half the pumping engines (twenty in number) were built by the Worthington Company, and are of the triple-expansion, surface-condensing, high-duty type. Twelve of these engines, for stations 1 to 4, each pump 1,945 imperial gallons per minute against a head of 450 feet, and eight of the engines, for stations 5 to 8, each pump 3,890 imperial gallons per minute against a head of 225 feet. The contract provided that the efficiency of these engines should be measured by a duty of 135,000,000 foot-pounds per 1,000,000 B. T. U. Upon the official tests the engines performed a duty of 142,931,000 foot-pounds per 1,000,000 B. T. U. All the boilers for the stations are of the Babcock & Wilcox make, working under a pressure of 175 pounds per square inch. For the facts in the above we are indebted to an interesting article which appeared in the March issue of the *Canadian Engineer*.

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PROGRESS ON THE PENNSYLVANIA TUNNEL.

Work is well under way on the tunnels under North and East rivers, by which the Pennsylvania Railroad will enter New York City. Compressed air is to be used very extensively in the pushing of the immense tubes under the rivers and the compressor plants will represent the latest developments of pneumatic practice. The contracts for the air-power equipments were awarded to the Ingersoll-Sergeant Drill Co., New York, who are now installing the machinery.

The work is to be carried on in two distinct sections and under separate contracts. The larger of these, for tunneling under the East River—secured by S. Pearson & Son, Inc.—provides for building four parallel tubes between Long Island and Manhattan, each to be 33 feet in diameter. The work is to be pushed from both ends at the same time.

The four power plants being installed for the work represent in the aggregate the largest installation of air-compressing machinery ever made for general power purposes, and every refinement has been applied which could contribute to economy and reliability, for when the work is once under way no interruptions can be permitted. The main air-compressing plants on the East River tunnel will include twelve Ingersoll-Sergeant cross-compound Corliss steam-driven compressors, with duplex air ends of the latest type. Eight of these are low-pressure units, each with a capacity of 5,000 cubic feet of free air per minute, compressed to 50 pounds from atmospheric intake. This air is to be used for keeping out the water and mud when the shields are driven forward. There will be two high-pressure compressors designed to draw their intake either from atmospheric or from the discharge of the low-pressure machines. In the former case the capacity is 1,500 cubic feet of free air compressed to 100 pounds; in the second case it is from 2,000 to 6,600 cubic feet delivered at pressures up to 150 pounds. This high-pressure air is to be used for running rock drills, driving concrete mixing machines, and possibly for pneumatic haulage. The remaining two units are combination compressors having steam cylinders coupled in tandem to two pairs of duplex high and low-pressure air cylinders. Either set of compressing cylinders may be thrown into operation, the machines thus serving as reserve units for either the high or low-pressure compressors.

The contract for the North River tunnel is not so extensive, there being only two tubes to be built, of 33 feet diameter. The machinery for this also is being installed by the Ingersoll-Sergeant Drill Co. Eight compressor units are to be used, four on each side of the river. These are of the steam-driven, cross-compound Corliss type, with duplex air ends, six being low-pressure machines and two high-pressure. The air is to be used for the same purposes and in the same manner as in the East River tunnels.

* * *

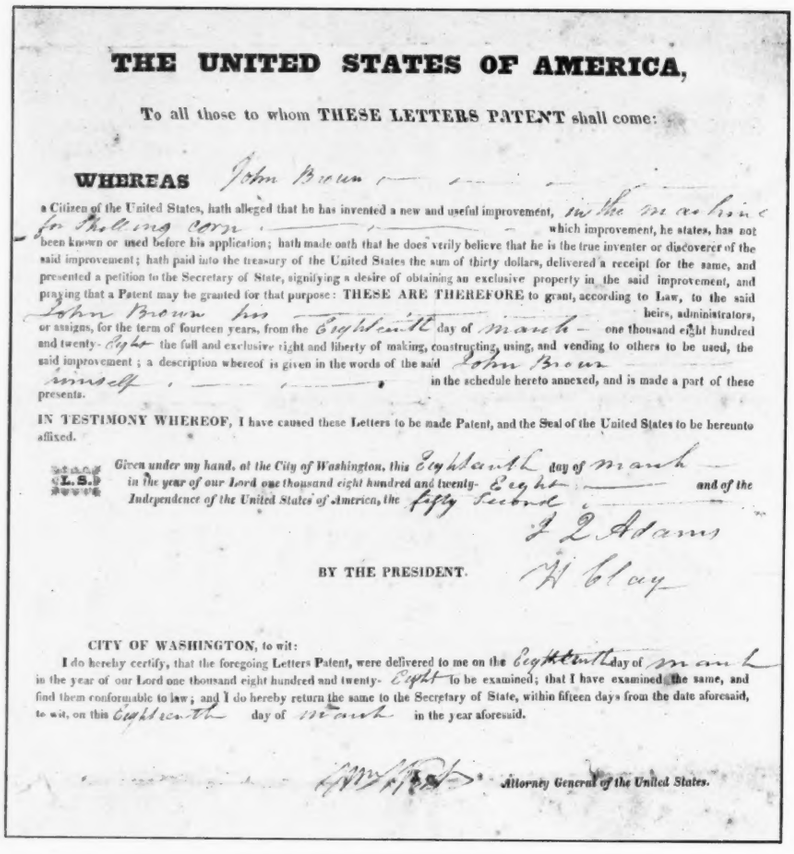
A revival of American machine exports to Germany is reported by Consul-General Mason, of Berlin, the exports of machine tools for 1904 being 1,634 metric tons as against 724 metric tons in 1903. Equally as great improvement is noted in the case of sewing machines, pumps, typewriters, electric machines, etc. Mr. Mason says that it is because American manufactured articles are well known and appreciated in Germany that the demand for them has recovered and kept pace with the general revival of prosperity in that country.

COPY OF A PATENT ISSUED IN 1828.

In 1828 John Quincy Adams was president of the United States and Henry Clay was secretary of State. Among the important duties that these gentlemen had to perform in carrying out the business of the government was the signing of patent papers issued to inventors. One of the patents taken out in this year and signed by the president and his first adviser was issued to a certain John Brown and the specifications are here reproduced, by means of the half-tone plates and the text printed on the next page. The patent itself was about as ordinary as the name of the inventor and related to a corn-shelling machine which consisted of nothing more nor less than a hole in a board or other flat surface, having expanding sides and through which ears of corn were to be driven by means of a mallet scraping away the kernels.

It can hardly be imagined that Theodore Roosevelt or John Hay, in fulfilling the duties of their high offices, should devote much time to matters so trivial as patents upon corn-shelling machines. The development of the country and of its many interests, both foreign and domestic, call for other work on the part of the chief executive. The establishing of our patent system, however, in the early days of our government was an event that has had as much to do with the industrial success of the country, and the organization of our great industrial enterprises as any other one thing. Protection to inventors, by means of the patent system at once led to a feeling of confidence on their part that their rights would be protected, and the organization of a patent system was of as great national importance in 1828 as the building of the Panama Canal is in 1904. It was quite right, therefore, that the highest officers of the government should give this subject their personal attention, even though it led in some instances to the trivial duty of signing patent papers like the one reproduced herewith.

The patent system of the United States was organized in 1770, but it was not until 1836 that the system practiced as it is to-day was inaugurated. Prior to 1836 there was no critical examination of the state of the art preliminary to the allowance of a patent application. The first patent granted by the Government was to Samuel Hopkins in 1780, for an improvement in pot and pearl ash manufacture. The last patent granted in 1889, at the close of the first hundred years of patents issued, was for an electromagnetic typesetting machine. These two patents are suggestive of the progress of the century. We are able to reproduce this early patent paper through the kindness of Mr. H. K. Harring, Ossining, N. Y., who sent it to us for publication. The document was made out on a four-page sheet, the first and second pages of which are shown in Figs. 1 and 2. The matter written on the last two pages is given in what follows:



THE UNITED STATES OF AMERICA,

To all those to whom THESE LETTERS PATENT shall come:

WHEREAS John Brown

a Citizen of the United States, hath alleged that he has invented a new and useful improvement, in the machine for shelling corn, which improvement, he states, has not been known or used before his application; hath made oath that he does verily believe that he is the true inventer or discoverer of the said improvement; hath paid into the treasury of the United States the sum of thirty dollars, delivered a receipt for the same, and presented a petition to the Secretary of State, signifying a desire of obtaining an exclusive property in the said improvement, and praying that a Patent may be granted for that purpose: THESE ARE THEREFORE to grant, according to Law, to the said John Brown his heirs, administrators, or assigns, for the term of fourteen years, from the Eighteenth day of march one thousand eight hundred and twenty-Eight the full and exclusive right and liberty of making, constructing, using, and vending to others to be used, the said improvement; a description whereof is given in the words of the said John Brown himself, and in the schedule hereto annexed, and is made a part of these presents.

IN TESTIMONY WHEREOF, I have caused these Letters to be made Patent, and the Seal of the United States to be hereunto affixed.

L.S.

Given under my hand, at the City of Washington, this Eighteenth day of march in the year of our Lord one thousand eight hundred and twenty-Eight and of the Independence of the United States of America, the fifty Second.

J. Q. Adams

BY THE PRESIDENT.

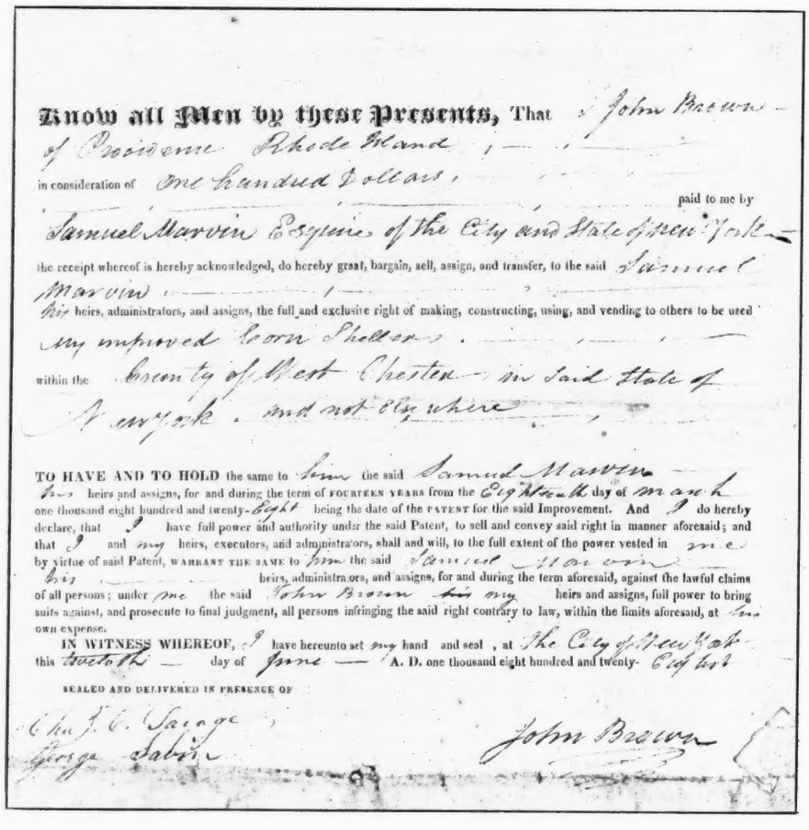
H. Clay

CITY OF WASHINGTON, to wit:

I do hereby certify, that the foregoing Letters Patent, were delivered to me on the Eighteenth day of march in the year of our Lord one thousand eight hundred and twenty-Eight to be examined; that I have examined the same, and find them conformable to law; and I do hereby return the same to the Secretary of State, within fifteen days from the date aforesaid, to wit, on this Eighteenth day of march in the year aforesaid.

Attorney General of the United States.

Fig. 1. First Page of Patent Specification, signed by John Quincy Adams and Henry Clay.



Know all Men by these Presents, That I John Brown of Providence Rhode Island, in consideration of one hundred Dollars, paid to me by Samuel Marvin Esquire of the City and State of New York, the receipt whereof is hereby acknowledged, do hereby grant, bargain, sell, assign, and transfer, to the said Samuel Marvin his heirs, administrators, and assigns, the full and exclusive right of making, constructing, using, and vending to others to be used my improved Corn Sheller, within the County of West Chester in said State of New York, and not elsewhere,

TO HAVE AND TO HOLD the same to him the said Samuel Marvin his heirs and assigns, for and during the term of FOURTEEN YEARS from the Eighteenth day of march one thousand eight hundred and twenty-Eight being the date of the PATENT for the said Improvement. And I do hereby declare, that I have full power and authority under the said Patent, to sell and convey said right in manner aforesaid; and that I and my heirs, executors, and administrators, shall and will, to the full extent of the power vested in me by virtue of said Patent, WARRANT THE SAME to him the said Samuel Marvin his heirs, administrators, and assigns, for and during the term aforesaid, against the lawful claims of all persons; under me the said John Brown his my heirs and assigns, full power to bring suits against, and prosecute to final judgment, all persons infringing the said right contrary to law, within the limits aforesaid, at his own expense.

IN WITNESS WHEREOF, I have hereunto set my hand and seal, at the City of New York this twentieth day of June A. D. one thousand eight hundred and twenty-Eight

SEALED AND DELIVERED IN PRESENCE OF

Chs. J. C. Savage
George Sabin

John Brown

Fig. 2. Second Page of Specifications.

The Schedule Referred to

IN these Letters Patent and making part of the same, containing a description, in the words of the said JOHN BROWN himself of his improvement in the MACHINE FOR SHELLING CORN.

To all persons to whom these presents shall come, John Brown, of Providence, State of Rhode Island, gentleman, sends greeting. Be it known that I, the said John Brown, have invented, constructed, made and applied to use a new and useful improvement in a machine for shelling corn, specified in the words following to-wit:

My improvement is to drive the ear of corn or cob thro' holes, with a mallet or any other suitable apparatus. These holes may be in hard wood or metal, the latter is preferable for durability. The holes may spread or open by sections, and when the cob is driven in, those parts or sections may be driven back by springs, or any method may be adopted, as to the form and construction of the holes which an ingenious mechanic may think best to effect the same object. I prefer the following method, to-wit: Take a plate of cast iron about one foot in length, three inches in width and half an inch thick, with five or more holes of different diameters, with a ridge round the holes rising about one-quarter of an inch above the surface of the plate in a conical form. This plate is attached to a bench similar to a carpenter's saw bench, by which the ear of corn is held in a vertical position while driving through the hole with the right hand at the same time replenishing the ear with the left hand. I drive the small end of the ear "or cob" in a smaller hole from one to three or four inches before it enters the hole intended to pass thro' as the shape of the ear may require. It will be understood the corn flies off above the holes in said plate. A piece of coarse cloth resting on wire is attached to the end of the bench round the plate of iron to prevent scattering the corn, by which it is guided to a basket and the cobs separated, or the corn may pass into a coarse wire sieve or riddle. A small room, or partition in the corner of a room, may be substituted for the cloth round the iron plate above mentioned. Both may be dispensed with in warehouses where scattering the corn can do no injury. * * *

The advantages of this machine over others for shelling corn are cheapness, durability and simplicity, requiring no repairs, and if most convenient the labour only of children. I claim the application of driving the ear of corn or cob thro' holes as above described. In testimony that the above is a true specification of my said improvement as above described I have hereunto set my hand and seal, this twenty-seventh day of February, A. D., in the year one thousand eight hundred and twenty-eight. (Signed) JOHN BROWN.

Witness: John Barton, Philip Green.

* * *

THE PANAMA CANAL.

At the monthly meeting of the American Society of Mechanical Engineers for March, held at their New York house, Mr. W. R. Warner, of the Warner & Swasey Co., Cleveland, gave a talk on the Panama Canal. Mr. Warner recently accompanied a commission of congressmen on a trip to Panama, he, however, going simply as a private citizen. His opportunities for observation were, of course, unusual and, as might be expected, the love for investigation which characterizes the trained engineer, led him to inquire into many interesting facts that he related in an anecdotal way, affording much pleasure to the large audience that filled the hall. Mr. Warner is strongly in favor of a sea-level canal. It appears that if a canal with locks should be constructed, having a summit level of 85 feet elevation, as originally planned, an immense dam must be built at Bohio, across the valley in which the Chagres river flows, thus forming a lake at the water level of the highest lock in the system. This dam would have to be 2,000 feet long and under the best of conditions would be a great undertaking. Recent borings, moreover, show that the foundations would have to be carried about 150 feet below sea level, thus greatly increasing the obstacles in the way of its construction. After the dam was built and the canal finished, on the basis of 85 feet elevation, it would not prove satisfactory for all time and eventually the work would have to be undone and a sea-level canal finally built.

In the case of a sea-level canal the Chagres river, which crosses the path of the canal, would be controlled by a less expensive dam at another point on the Isthmus, and its channel diverted.

Drawings showing a cross-section of the Isthmus, and the proposed canal, it was pointed out, are often misleading to the casual observer because they are drawn to so contracted a longitudinal scale and so large a vertical scale that they give the impression of immense depths to be cut through an extremely mountainous region. As a matter of fact the greatest depth at the Culebra cut, where the most extensive diggings have to be made, is 275 feet, which the French company in their operations reduced to 150 feet. The dimensions of the canal, as laid out by the French company, were smaller than at present considered, so that some cutting would have to be done from the total height of 275 feet down to the 150-foot level, in order to secure the requisite width of canal. The point made by Mr. Warner, however, is that the amount of digging to be done is not so great as is generally supposed, and with modern machinery it is entirely possible to complete the canal at sea level within 10 or 12 years.

This result, if accomplished, will be due largely to the great efficiency of the modern American steam shovel. There are now three such shovels at work on the Isthmus, with a view to determining the amount of excavating that can be accomplished with them in a given time, and it is found that whereas previous estimates have been for a cost of 80 cents per cubic yard of material removed, present estimates based on the work of these machines are at the rate of 50 cents per cubic yard. The shovels are able to do much more than was anticipated, and the added cost of a sea-level canal over the estimate of the previous commission which investigated the subject, for a canal having a summit level of 85 feet elevation, is less than $80,000,000—not a large sum when it is considered that New York State alone is preparing to spend $100,000,000 for its canal. It is proposed to add more shovels at frequent intervals until 100 have finally been set to work. The chief difficulty in excavating will be in disposing of the material, which must be done by means of cars and temporary lines of tracks.

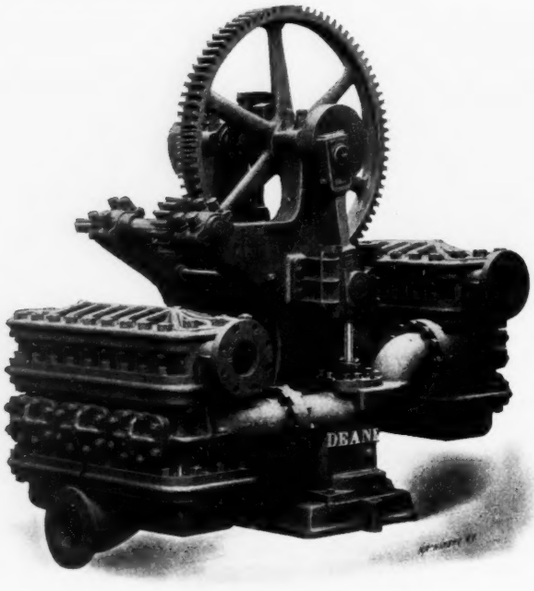
There is a force of several thousand employes of the government now at work on the Isthmus, this force including the medical staff, sanitary commission, etc., as well as the workmen and engineers.

Among the many interesting photographs thrown on the screen by Mr. Warner were several of the French excavating machines that had been left to rust for twenty years, since the work was begun by them. It is a sad sight to see literally miles of what was finely-built machinery in almost a hopeless state of ruin. Nearly all the French excavators are built on the plan of dredging machines having an endless chain of scoops which remove the dirt, mud or other material continuously instead of intermittently, like the steam shovels. For the removal of earth and broken stone this type is much less efficient than the shovel, but for removing mud and soft earth it is even more efficient than the shovel, so that it is the intention to repair many of the French machines and use them for taking out the soft material from the sides and bottoms of the parts of the canal already excavated.

Following Mr. Warner's talk Prof. Burr of Columbia University, a member of the Panama commission, and who had just returned from the Isthmus, gave an interesting statement on the subject, which of course was authoritative. Among other facts he told the inside history of the original recommendation of the former commission, of which he was a member, in favor of the Nicaraguan route. While from the engineering standpoint the Panama route was preferred the French company existing at that time made a demand for more than twice what the commission believed to be a fair estimate of the value of the property. The obvious way to accomplish a settlement on a more reasonable basis was to recommend another route which, if adopted, would destroy absolutely the value of the Panama property. This was done, whereupon the French company was reorganized and the new officers were very willing to accept the $40,000,000 proposed by the United States as compensation.

PUMPING HEAVY FLUIDS.

In many industries it is necessary to force heavy, viscous liquids through pipes, which involves difficulties not encountered in ordinary pumping, and requires machinery special in design and construction. When the liquid is heavy, but not adhesive, as in the case of heavy oils, the action can be made fairly efficient by enlarging the valve openings, making the parts of the pump heavier, and so arranging the passages that there is little likelihood of choking or clogging. When, however, the liquid is a fluid at high temperatures, but a gelatinous adhesive paste or a rubbery solid, clinging to all surfaces and choking openings through which it should pass, as the temperature is lowered, a design differing materially from the ordinary pump must be used. Tar, molasses, and cocoa liquor present more obstacles to pumping than any other substances which it has been found feasible to move in this manner. Each of these liquids thickens into an almost solid mass when cold, rendering it very difficult to start the pump, unless some special provision is made and ample power provided. Another action which must be taken into account is the contraction of the area of the passages and valves as the liquid cools and the consequent throttling which interferes with the liquid's passage and which the pump is forced to overcome. The skin friction of a liquid of this kind creates heat enough to partially alleviate this tendency to throttling when the velocity of the substance is maintained above a certain point and the pipe is in such a position that the surrounding air will not lower the temperature of the liquid below the solidifying point. Although not a common practice, it is well to lag all exposed piping used for conveying heavy oils or other substances of a similar nature.



Special Pump for Heavy Fluids.

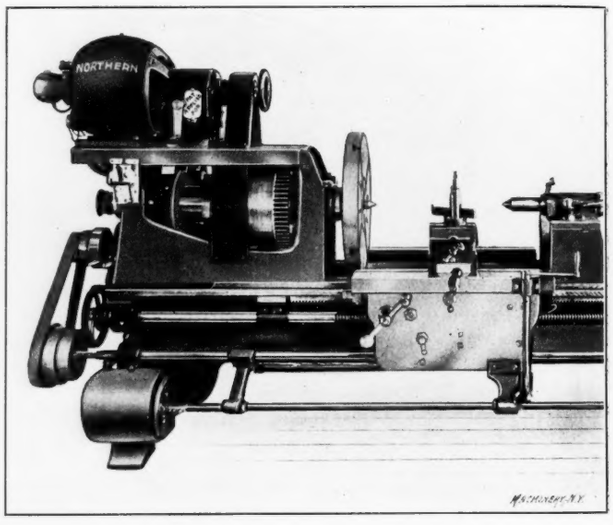
A liquid peculiarly difficult to handle is oil-refinery tar, which is usually very hot when it reaches the pump. There is a large percentage of suspended particles of various sizes present in this tar and also a certain amount of unrefined paraffin. The tar is sometimes heated to a temperature of 300 degrees, but quickly cools off if not properly handled, coating the retaining valves and walls with layers of an adhesive substance closely resembling finely divided particles of coke. To overcome this the ordinary pump arrangement is materially changed. The cut shows a pump installed by the Deane Steam Pump Co., Holyoke, Mass., for handling oil-refinery tar at the works of the Atlantic Refining Co., in Philadelphia. By a new arrangement, large valve areas are made available, designed to permit the passage of the substance pumped with the least possible frictional resistance. The suction, discharge, and pulsation chambers can be taken apart without unnecessary expenditure of time or labor, and each is in a position where it can be readily reached for cleaning. The pump is of the triplex type, fitted with ball valves which thorough test has proved best adapted for the passage of heavy substances. There are a number of large handholes for cleaning the valves. The figure shows the rigid crosshead guide system and the strong design of the chambers, rods, pistons, and bearings.

* * *

MOTOR DRIVES FOR OLD TOOLS.

The conversion of existing machine tools from the belt-driven into the individual motor-driven type, with the least expenditure of time and labor, is a problem apparently solved in the case of the lathe shown in the accompanying illustration. The Northern Electrical Mfg. Co., Madison, Wis., have taken this problem definitely in hand, and adapted one of their types of motor to the service. The change made consisted in the addition of a special bonnet or end case, containing a change gear device, to the motor.

The cut below shows a 24-inch engine lathe, which the Northern Electrical Mfg. Co. equipped with a motor in place of the belt drive formerly used with this machine. To make this change the bearing caps of the spindle bearings were taken off, and a saddle designed to rest on the spindle bearing housings, to span the cone, fastened in place. Upon this saddle, which now formed part of the spindle bearings, the motor equipment was installed. The cones were left in place, and a split gear clamped to the second largest cone. The spindle is driven from the motor pinion through a silent chain to the split gear on the cone.



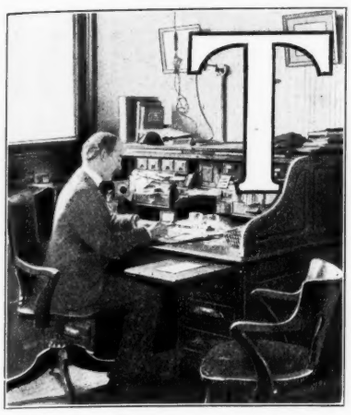
Old Lathe of Standard Design Fitted with Motor.

The motor used is the Northern multi-speed, which supplements the electrical speed variations secured by the motor winding by the gear ratio supplied by the change gears. In this case the variation is of about 7 to 1. The total number of speeds depends of course upon the number of points in the controller; in this case the controller has twenty points. There are available, then, twenty speeds through motor direct, twenty more by using the change gears, and, as back gears of the lathe may be used with any of the above forty speeds, eighty in all, whereas the original belt drive allowed only eight. The spindle speeds of the lathe now range from 3½ revolutions per minute to 330 revolutions per minute.

The lathe speeds are controlled through two levers. Of these the one at the right end of the lathe apron, actuating the controller, is commonly used. It operates through the medium of the bevel gears and the splined horizontal rod, as shown. The other lever, which manipulates the change gears, is only used when the controller cannot produce the speed required.

Gears and clutches run in oil. The motor used with this system takes current from a two-wire direct-current circuit. While the motor here used is variable speed, a constant speed motor could of course be used if only two speeds were required. These could be obtained through the change gears, a change being made without the necessity of stopping the machine.

NEW PLANT OF THE RIDGWAY MACHINE TOOL CO.—A 10-16 FOOT BORING MILL THE FIRST TOOL PRODUCED.



Mr. L. H. Morgan, Superintendent and General Manager.

THE Ridgway Machine Tool Co., Ridgway, Pa., was organized about two years ago for the manufacture of heavy machine tools, such as boring mills, planers, engine lathes, driving wheel lathes, etc. On January 14 last the first machine was completed and shipped. It was a 10-16-foot extension boring mill of massive construction, designed for use with high-speed steels, and was shipped to the Bucyrus Co., South Milwaukee, Wis., for work upon the heavy machinery which this concern is building for the Panama Canal.

In the interval between the organization of the company and the first shipment a large and modern plant has been constructed and equipped with new tools, a considerable number of patterns are already completed for various machines, and there are now 150 men employed, with orders enough ahead to keep this force busy for twelve months.

The new company is controlled entirely by local capital, which speaks well of the prosperity of the community and of the enterprise of its citizens. The officers of the company comprise the following gentlemen: H. R. Hyde, president; P. R. Smith, vice-president; R. J. Powell, secretary, and E. C. Powell, treasurer. The superintendent and general manager of the Ridgway Machine Tool Co. is Mr. L. H. Morgan, for many years with the Pond Machine Tool Co., Plainfield, N. J. The head draftsman and engineer is Mr. F. B. Cockburn, also formerly connected with the Pond Company.

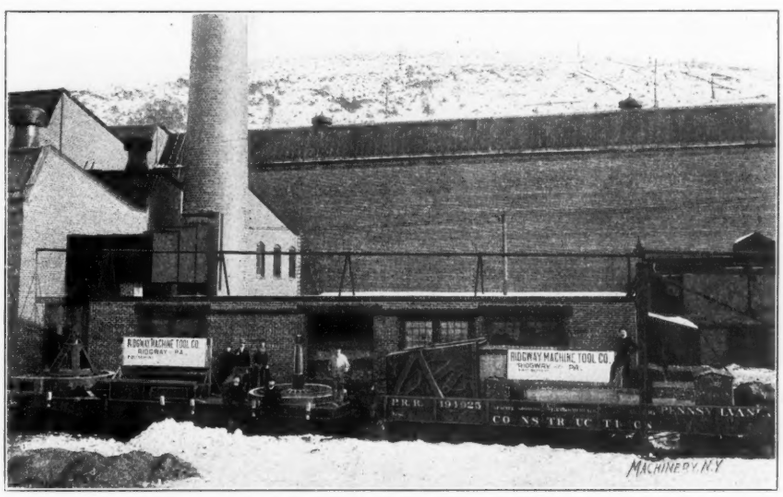


Fig. 1. An Important Event—the first Shipment, consisting of the 10-16 foot Extension Boring Mill described in this article.

The plant of the Ridgway Machine Tool Co. is equipped for the manufacture of the heaviest and largest sizes of machine tools and is large enough to accommodate several times the number of employes now at work. It is one of the few machine tool plants in the country equipped with its own foundry. The buildings are of steel construction, with saw-tooth roof, and the structures for the different departments are of different heights, to accommodate the class of work to be done. The crane and track service provided for handling the work in all the departments, and transferring it from one department to another, is more complete, even, than is usually found in modern shops, where a great deal of attention is always paid to these features. The arrangement of the several buildings is such as to insure progressive movement of the product through the several steps of manufacture, from the pattern shop and stock room to the point of shipment. Provision is made for enlarging any or all of the departments without destroying the continuity of arrangement, and if, for example, the whole plant should have to be doubled in size the same systematic plan for the movement of the work could still be maintained.

In Fig. 6, on the next page, is a plan of the works. Starting at the left are the pattern shop and pattern storage building, where also are located the offices. Next comes the wash room, fitted with expanded metal lockers for the employees and it is here that the men employed in the different departments enter and leave the plant Following this comes the stock room where bar stock, bolts and similar stock are kept; and on the other side in the same end of the building, is the forge shop. The several departments mentioned are all included in a one-story building with roof made high enough to accommodate the work done in the forge and pattern shops, and to give good air and ventilation; but not as high as in the machine shop and foundry where head room for traveling cranes is required. This building is not of saw-tooth roof construction, but is lighted by side windows.

The foundry follows next and is offset to one side of the pattern and forge building, so that it can be extended to the left, alongside of the latter, to allow future growth. The foundry adjoins the machine shop and is of the same height as the erecting department of the machine shop. Both the foundry and erecting shop have head room enough for swinging the

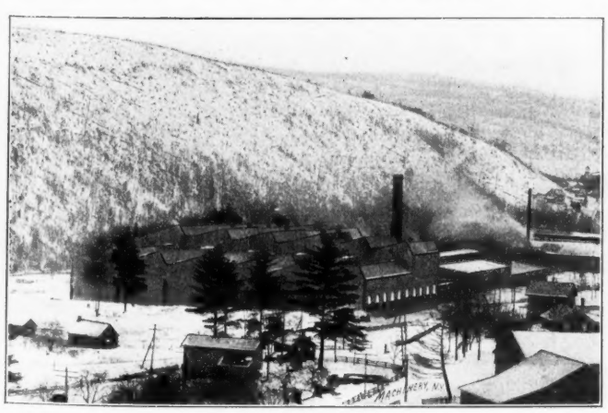


Fig. 2. General View of the Plant of the Ridgway Machine Tool Company.

Fig. 3. View of Works, showing Saw-tooth Roof Construction.

In Fig. 3 the Machine Shop is at the right of line A-B, the high portion being the Erecting Shop and C C C, etc, the bays for machine tools. The Foundry is at D and E.

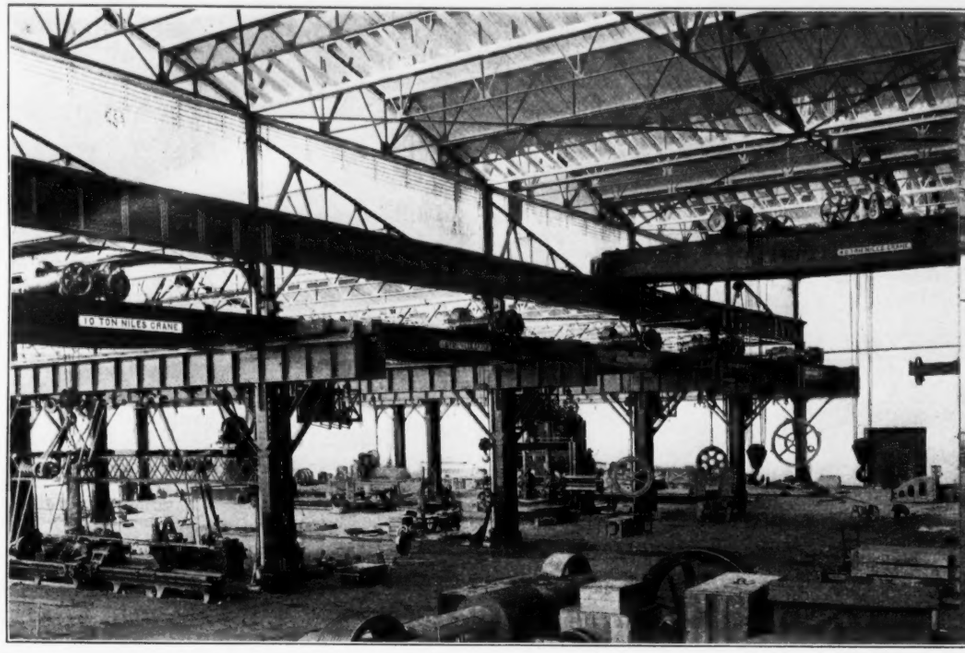


Fig. 4. Showing five Bays for the Machine Tools. Crane Tracks extend a short distance into the area of the Erecting Floor.

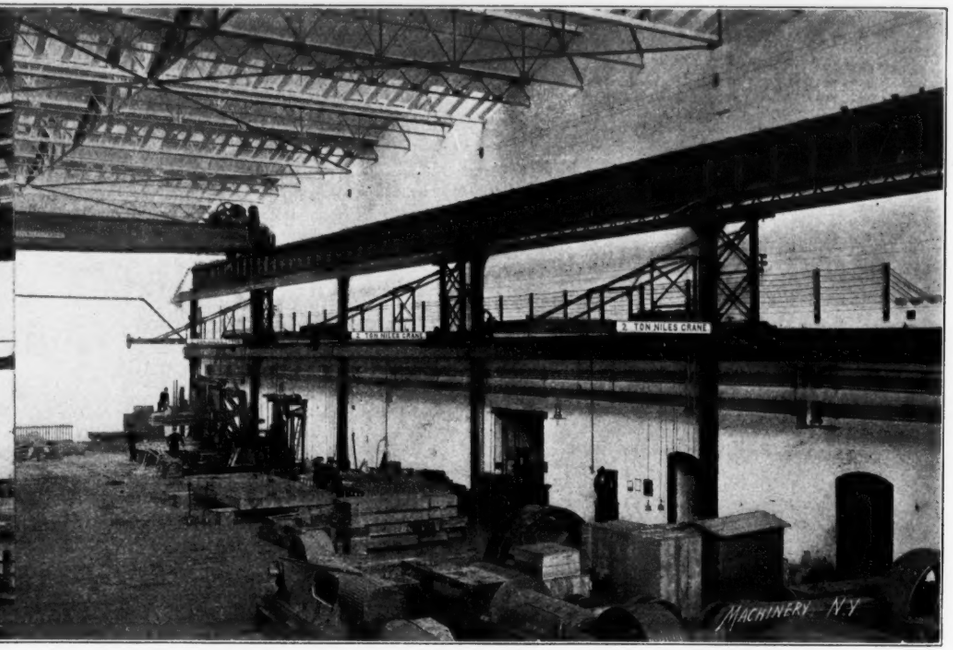


Fig. 5. Erecting Floor, served by a forty-ton Traveling Crane and three two-ton Cantilever Cranes.

General Views of Machine Shop.

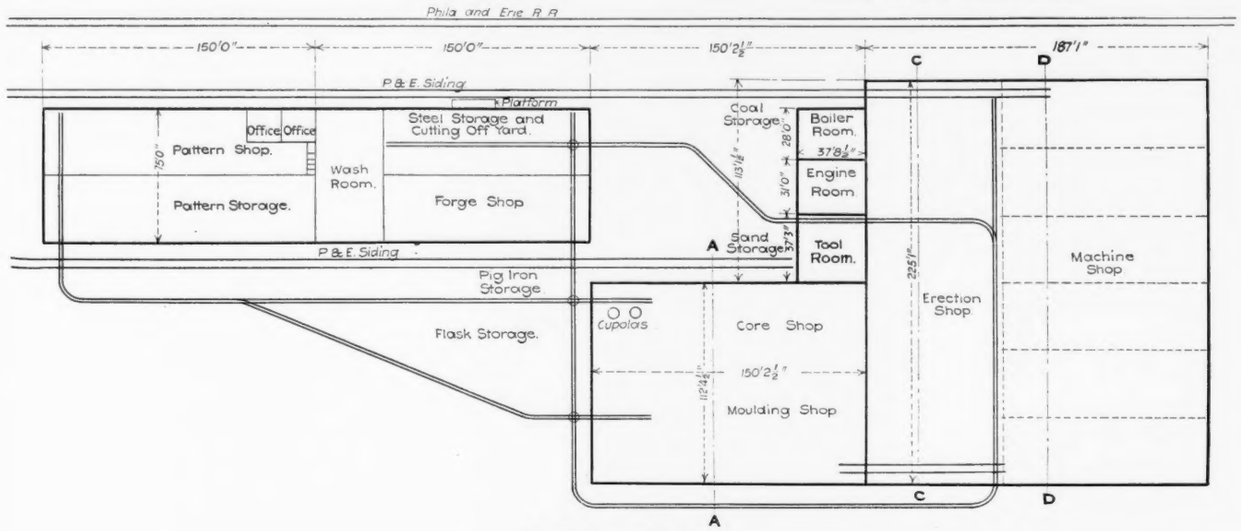


Fig. 6. Plan of Works.

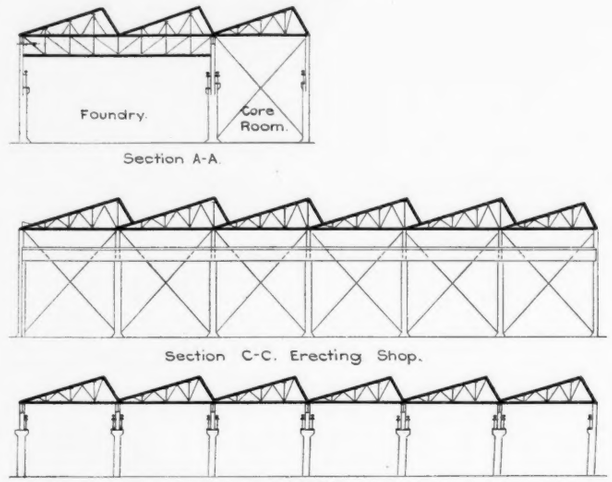


Fig. 7. Cross-sections of Buildings.

heaviest castings over any large work that may be on the floor, by means of the cranes which serve them. Still further to the right in Fig. 6, and at the extreme end of the plant, is located the machine shop proper, where the machine work is done. This part of the shop is built in the form of six bays, extending at right angles to the erecting shop. Each bay is served by a traveling crane and is lighted from the roof.

In Fig. 7, at the right of the plan view, are cross-sections taken on the lines *AA*, *CC* and *DD* of the plan, showing the relative proportions of the roofs, the heights of the crane runways, etc.

The half-tone view, Fig. 3, on the first page, is lettered to assist in further explanation of the scheme of construction. This view is taken from a position near the lower right-hand corner of the plant, in Fig. 6. It shows the blank walls on the two visible sides of the building, designed to be removed in case of further extensions. That part of the works to the right of the line *A B* is the machine shop, the high portion

Fig. 8. Drafting Room. Mr. F. B. Cockburn, Head Draftsman, is seated at the Desk.

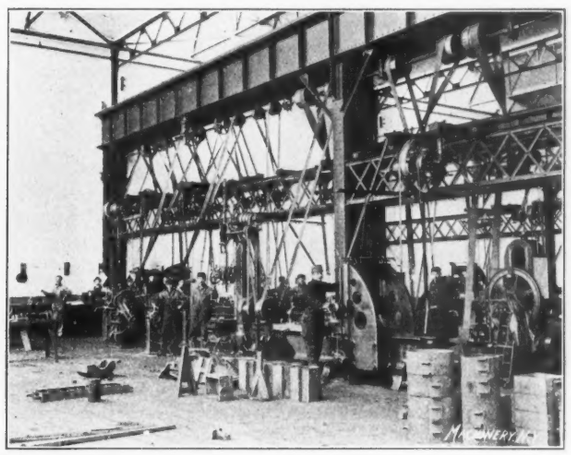


Fig. 9. Bay where Small Tools are Located. Latticed Girders used to support Countershafts.

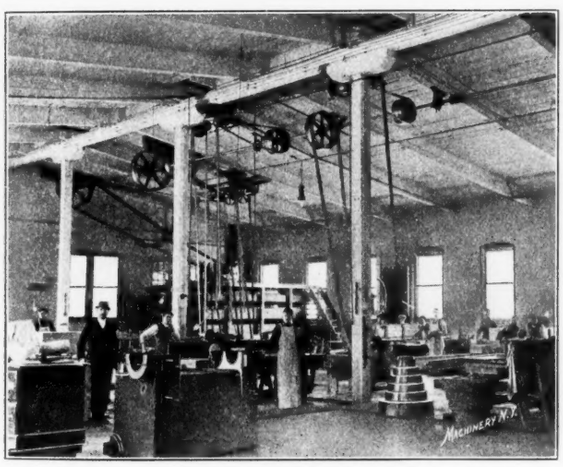


Fig. 10. Corner of Pattern Shop.

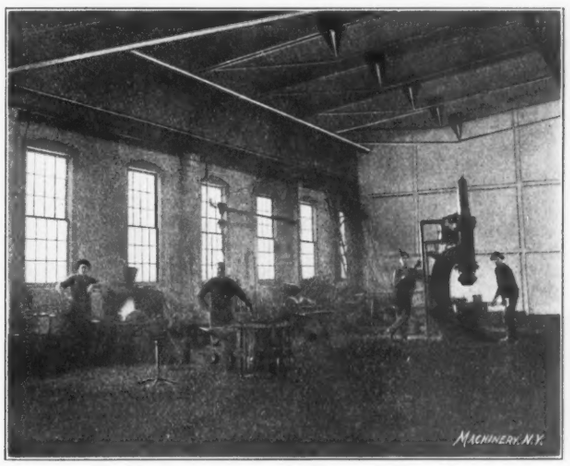


Fig. 11. Blacksmith Shop.

being the erecting shop, and *C*, *C*, *C*, etc., the bays for the heavy and light machine tools. The foundry is located under the sections *D* and *E* of the roof, and the pattern shop and blacksmith shop are still further to the left.

In equipping and organizing the plant, as much attention has been paid to the convenience and health of the employes as to any other features more directly associated with the output of the plant, as ordinarily considered. First of all, the water, taken from driven wells, is pure and is distributed throughout the works where it is supplied in sanitary porcelain drinking fountains. The fountains consist of small basins having a jet at the center which bubbles upward a distance of two or three inches, and the water may be taken into the mouth from this jet without the use of drinking cups. These fountains are exceedingly neat and are not only a convenience, but a marked improvement over the usual arrangement to be found in most manufacturing establishments.

Another convenience is the lunch room, which is located over the tool room, and where there are tables and chairs, and a gas stove is provided for the employes' use during the lunch hour. One of the regulations of the company is that no lunches shall be eaten in the shop proper, but that this room shall be used for that purpose.

Features of the Machine Shop.

In Figs. 4 and 5 are two general machine shop views, taken from nearly the same point of the erecting floor. The erecting shop is served by a 40-ton traveling crane with two trolleys and crane hooks for convenience in loading the tools for shipment. The car tracks run across one end of the erecting shop at right angles to the crane tracks, instead of parallel to the crane tracks, as is usually the case. In loading a lathe bed, for example, it would be set parallel to the car and then picked up by the two crane hooks and deposited on the car. It is the purpose to do much of the erecting on the right-hand side of the erecting shop (referring to Fig. 5) and for convenience in assembling the machines there are three 2-ton cantilever cranes on this side of the shop supported by wheels running on tracks which extend from end to end of the shop. A large bedplate 18 by 20 feet has recently been set in this shop, to be used in drilling, boring and milling some of the heavier work, by means of radial drills designed so that the vertical column of the drill can be bolted directly to the bedplate in any convenient position. These bedplates appear in Fig. 5, and beyond is the 10-16-foot boring mill already referred to, completed and ready for shipment. This mill was erected over a pit which has been sunk at one end of the erecting floor, for convenience in assembling parts which are located in the base of machines, an arrangement especially convenient in erecting boring mills and planers.

In the manufacturing part of the machine shop there are four bays fitted with 10-ton cranes, where the medium and small work is done, and two with 30-ton cranes for handling

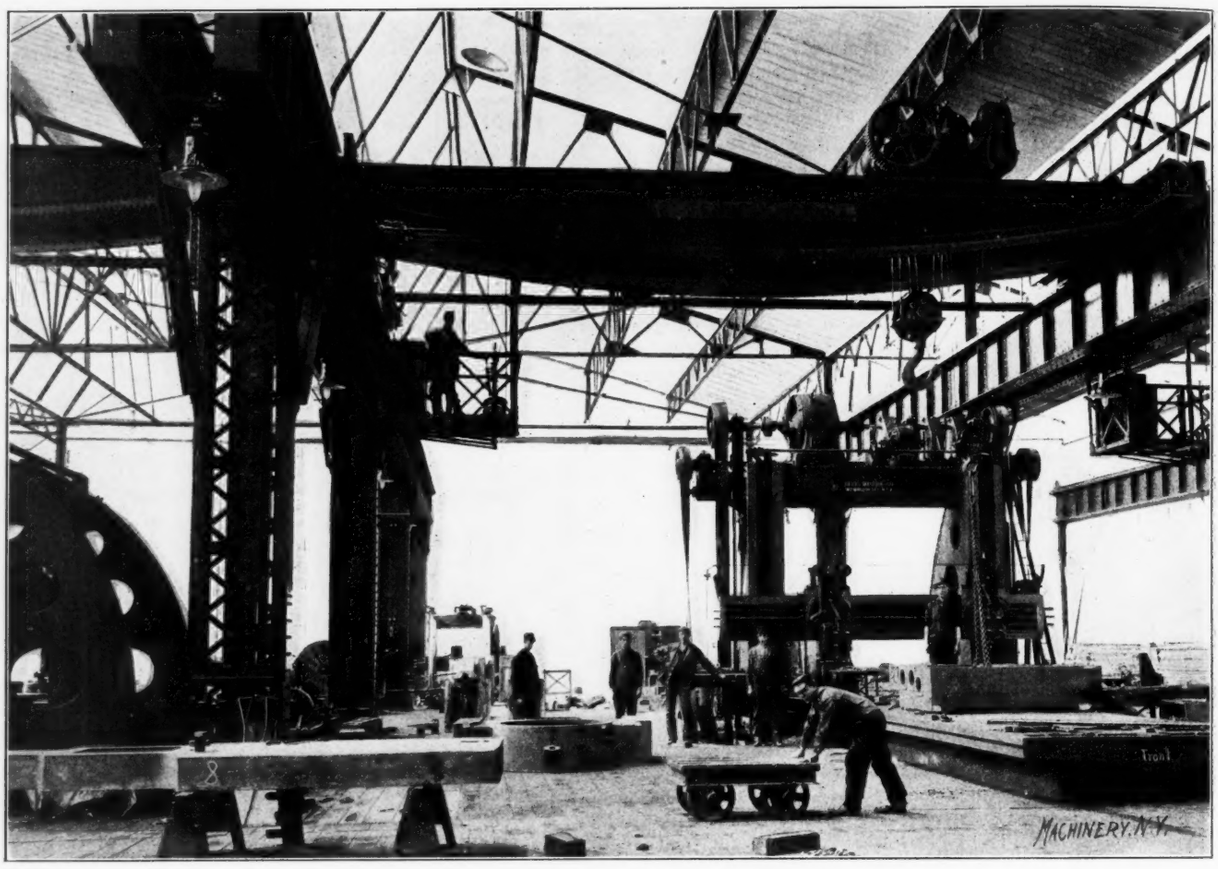


Fig. 12. One of the Machine Shop Bays where the Heavy Tools are Located.

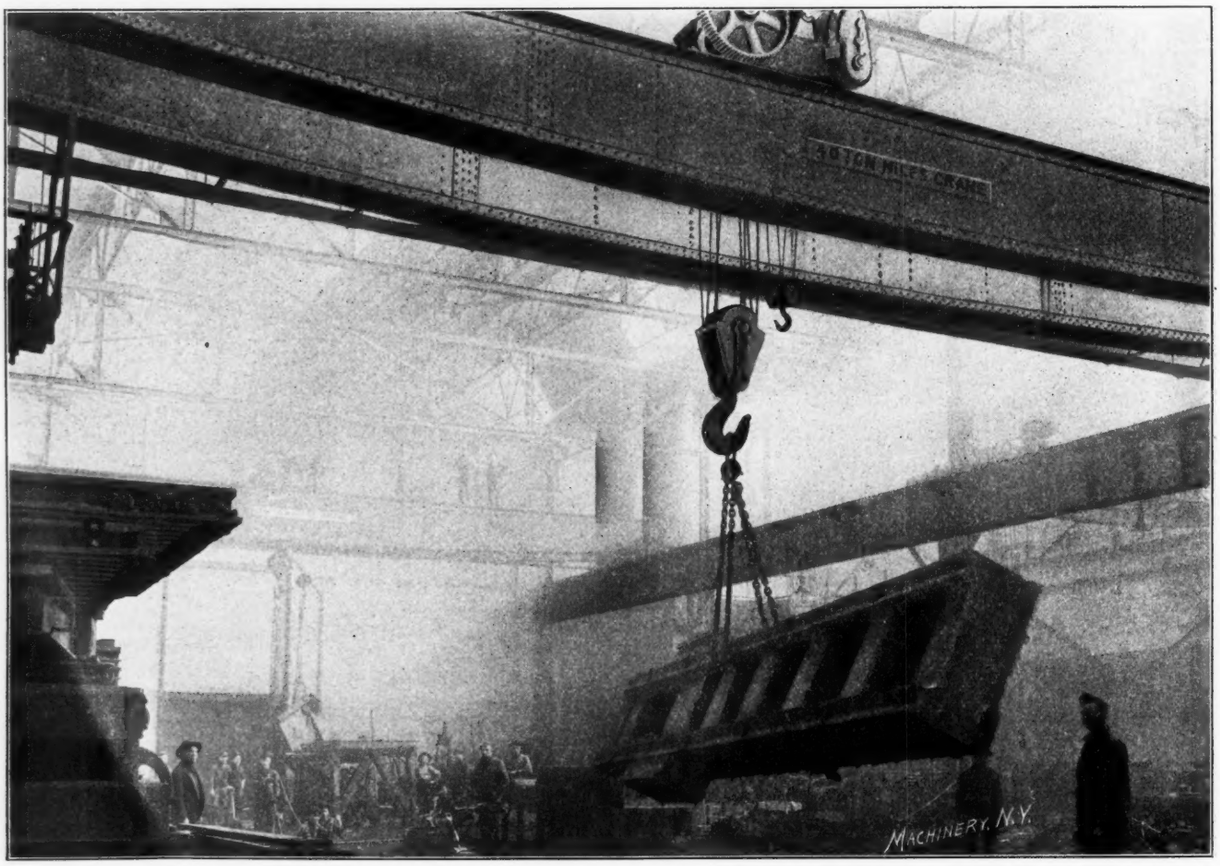


Fig. 13. Main Floor of Foundry, served by two Cranes of seventy-five foot Span.

the large castings to be machined by the heavy machine tools in this section. The tracks on which these several cranes run extend a few feet into the area of the erecting shop, to enable castings to be transferred from the machine working department to the erecting department.

Foundry and Blacksmith Shop.

The foundry is complete in its appointments and equipment for the turning out of a large quantity of heavy work. The main floor is served by one 40-ton and one 25-ton crane having the unusual span of 75 feet. The other section of the foundry is known as the core shop, where the cores are made and the small molding is done. The foundry is supplied with natural gas, compressed air, and with water from the service pipes of the plant. At every column in the foundry connections may be made for gas, water or compressed air, all of which are thus at the service of the workmen at any time and in any part of the foundry. The compressed air is used extensively, the foundry elevators even being operated by air pressure. Molding machines are employed for small work. Sand mixers, consisting of foundry riddles, given a reciprocating motion by small pneumatic pistons, have been found very serviceable both in sifting the sand and in mixing it. The core ovens are heated by natural gas, and gas is used more or less throughout the foundry for drying and hardening the surfaces of molds.

The blacksmith shop has down-draft forges, and the power hammer, like the elevators in the foundry, is operated by compressed air instead of steam. This feature is much appreciated because it avoids trouble from water of condensation, always present where steam is used, and a source of annoyance owing to its trickling down the piston rod and over the hammer head. Like the other parts of the plant, the blacksmith shop and the foundry are well lighted and clean.

Distribution of Power, Heat, etc.

The engine room and boiler plant are models in their arrangement and equipment. A 150-kilowatt generator, direct-connected to a tandem compound McEwen engine—both supplied by the Ridgway Dynamo & Engine Co.—furnish the power for the single-voltage system of 240 volts used throughout the plant. The works are wired in three separate circuits, one for the cranes, one for lighting and one for the shop motors. The circuits are also separate for each department and all the circuits are controlled at the switchboard in the engine room.

Water used at the works is obtained from driven wells, and in order to bring the pumps sufficiently near water level to raise the water it was necessary to place the pumps in a pit below the level of the engine room floor. There are two boiler feed pumps, a service pump, and a fire pump, the latter of 750 gallons per minute capacity. The service pump and fire pump are controlled by Mason regulator valves, and automatically maintain water pressure in the mains. The pumps are all piped so that any one of them may be shut off without interfering with the steam connections to the others—a problem that is not altogether easy to work out without complicating the piping.

The entire plant is heated by exhaust steam, and after mature consideration it was decided to use steam coils along the walls and under the roofs of the several buildings, as might be most convenient, instead of the forced hot-air system. The coils in the different departments are connected to main distributing pipes leading from the exhaust pipe of the engine and are so located that they drain away from the points where the steam is supplied to the coils. The drain pipes are all connected with the sewer, and although a very large number of square feet of heating surface are required for heating the works, and a great many separate coils are employed, no difficulty has been experienced in maintaining a flow of steam through all the coils. The plant has been heated in a satisfactory manner throughout the unusually cold weather of the present winter.

The First Boring Mill.

On the next page are two views of the boring mill just completed by the Ridgway Company, as it appeared set up in the shop. The most characteristic feature of the machine is the design of the housings which are made wide at the top instead of being of parabolic form, after the usual design. This construction enables a wide tie piece to be bolted between the uprights at the top and this, together with the cross-brace at the back, makes what is virtually a substantial box housing, closed on all sides but one, and that one stiffened by the cross rail itself. When the cross rail is at the upper end of the housings and the tool is taking a heavy cut, the thrust of the tool is resisted to a greater extent by both housings together (owing to the wide brace at the top) than would be the case if there were only a narrow brace at the top. By this means the most rigid possible construction is probably attained. The specifications for this mill call for two cuts, ½ inch deep, to be taken simultaneously on high tensile steel at a cutting speed of 40 feet per minute and 1-16-inch feed, on a circumference of 10 feet in diameter. After the mill was set up at the Bucyrus shops Superintendent Morgan visited the plant to demonstrate the capacity of the machine and brought home with him a collection of steel turnings that were so unusual as to excite the admiration of those who have seen them. They would probably satisfy the most ardent high-speed steel enthusiast. The mill was tested on high-tensile steel up to a point where the cut was from ½ to 1 inch deep, the metal turned being somewhat irregular, the feed was 3-16 inch and the cutting speed 50 feet per minute. This was accomplished at a circumference of 10 feet diameter, and 60 horse power was required, or twice the rated capacity of the motor, which, however, stood up to the work. The test broke the high-speed tool, and appeared to be the limit beyond which the tool could not go, showing that the mill was beyond the capacity of the high-speed steels.

To secure a strong drive for the table, the steel driving pinion meshes with teeth cut in a large steel ring about 8 feet in diameter placed under and attached to the table. The feed is by means of a friction drive shown in the side view of the mill, consisting of a friction wheel running in contact with a friction disk. The usual order of arrangement is reversed, however, because in this case the wheel drives the disk. To maintain sufficient pressure of contact, the disk and its supporting shaft are placed over the wheel and are kept in contact with it in virtue of their own weight. The wheel is made up of compressed leather disks bolted between the flanges, and in an annular recess in the face of the disk is secured a leather ring forming the friction surface against which the wheel runs. With these two leather surfaces in contact an abundance of power can be transmitted and the feed is easily adjusted by moving the friction wheels in or out from the center of the disk. This machine is driven by a 30-horse-power motor made by the Ridgway Dynamo & Engine Co.

This motor is designed with a 4 to 1 range having ten speeds by means of mechanical changes. Thirty table speeds are obtained in correct geometrical ratio, ranging from 25 feet per minute on a diameter of 6 inches to 16 feet per minute on a diameter of 16 feet. All changes are made by means of levers near the front of the mill within easy reach of the operator. Certain important dimensions are as follows: The table is 10 feet diameter, 10 inches deep at the edge, supported on a circular track of large diameter, which is so constructed that the bearing surface is immersed in oil. The spindle is carried in two bearings wide apart, to insure stability. The cross rail is 31 inches deep, and is held to the uprights by means of clamps on the inside edges so that the strain is not transmitted through the weakest part of the cross rail. There are also additional clamps on the outside edges of the uprights. The heads have a 34-inch bearing on the cross rail and the guiding surfaces are both on the lower edge of the cross rail, thus greatly diminishing the cramping action due to heavy cuts when the tool bars are extended below the cross rail. The tool bar is of large cross section and has a 4-foot travel. Each bar is separately counterweighted. The complete weight of the machine is 106,000 pounds.

It is the purpose of the Ridgway Machine Tool Co. to use the Thompson-Ryan variable-speed motors, built by the Ridgway Dynamo & Engine Co. as a feature of their machines, and in some cases the design of the machine will be made dependent upon the use of this motor as, for example, in their radial drills. A description of the Thompson-Ryan variable-speed motor and the system of control appears in this number as one of the series of articles upon variable-speed motors by Mr. Baxter, now running. In this motor a speed variation

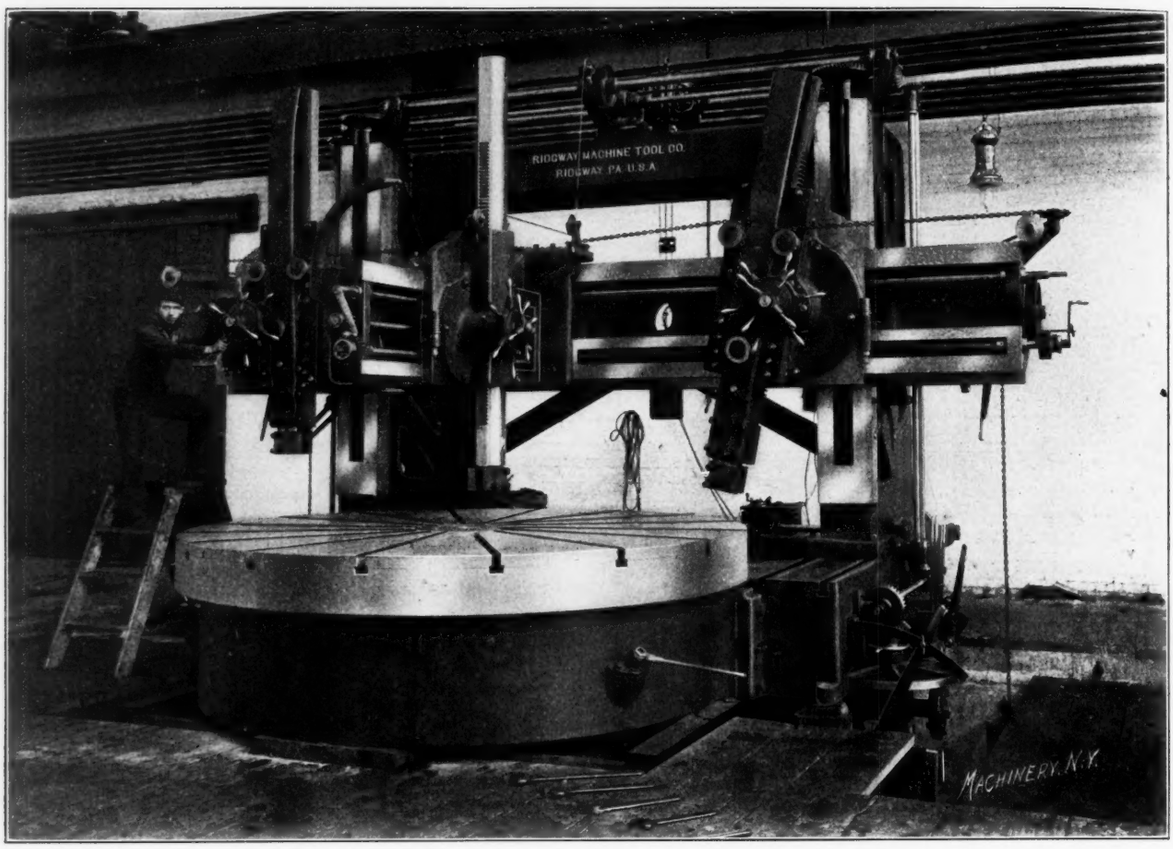


Fig. 14. Ten-sixteen Extension Boring Mill, Built for and Installed at the Bucyrus Company, South Milwaukee; weight, 106,000 pounds.

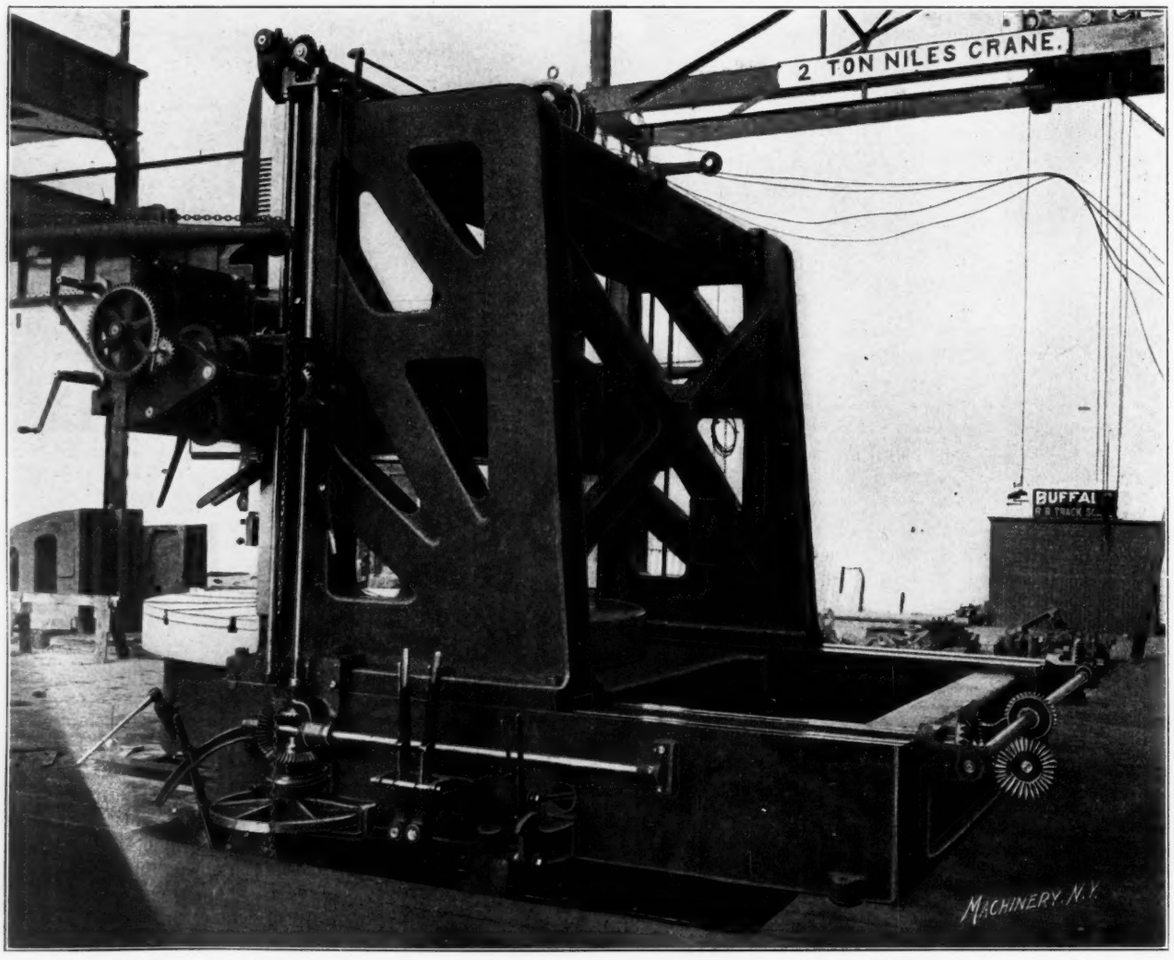


Fig. 15. Rear View of ten-sixteen Extension Boring Mill, showing Rigid Construction of Uprights.

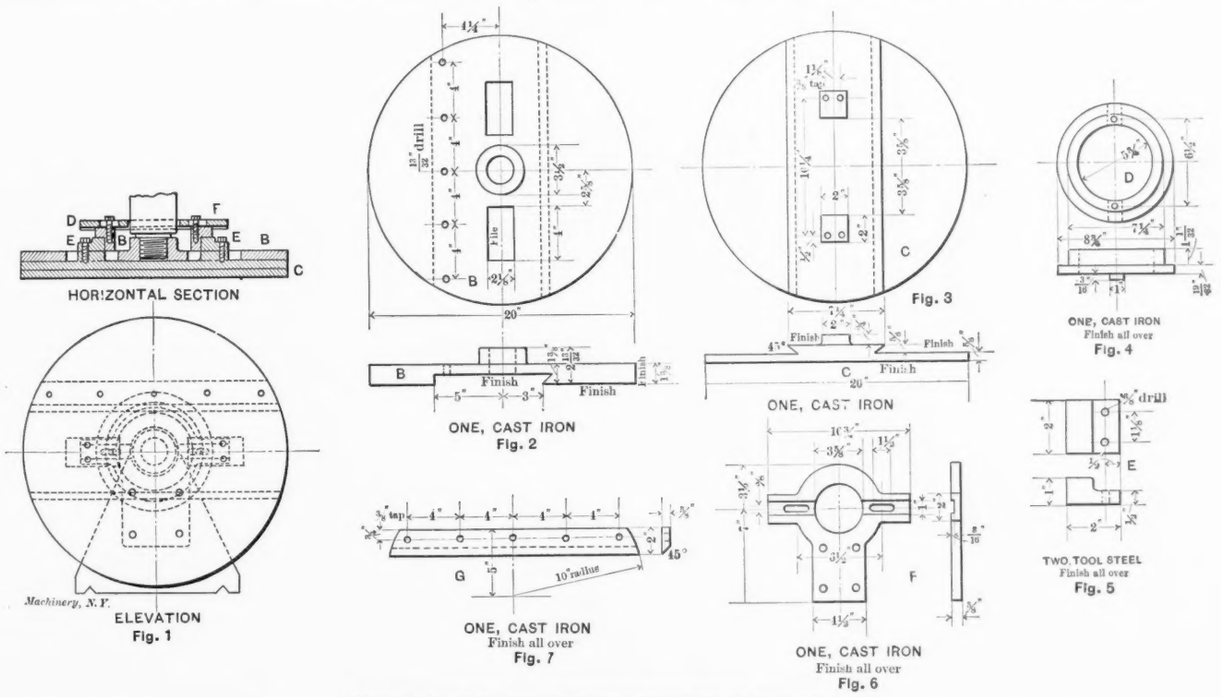
as great as 6 to 1, or even more under certain circumstances, is obtained with a single-voltage two-wire system without the sparking of the brushes, by means of so-called balancing rings carrying magnetizing coils placed between the field and armature. The magnetizing action of the coils is directly opposed to that of the armature and neutralizes the distortion of the field that occurs when a wide variation in the speed is attempted on the single-voltage system. All the cranes in the works are driven by these motors, having a speed variation of 4 to 1. The larger tools are also equipped with them, and the smaller tools are driven in groups through countershafts. One unusually interesting application of the motor is the driving of a 48-inch Pond planer by attaching the motor direct to the driving shaft in place of the belt pulleys. The motor reverses with each reversal of the planer and gives a range of table speeds from 20 to 60 feet per minute. A small pilot controller, operated by the usual dogs on the planer table, controls the main controller, and the reversal is said to be so accurate that not only does the table stop at a line, but the armature of the motor itself stops at a line. The reversal is gradual and the drive is giving good satisfaction in spite of the fact that the momentum of the rotating parts of the motor represents a large quantity of stored energy to be overcome. The details of this drive are not yet available for publication, but the motor is said to work alternately as motor and generator at the points of reversal, feeding current into the line when the armature is being brought to rest.

* * *

ELLIPTICAL CHUCK.

JOHN D. ADAMS.

The accompanying cuts, Figs. 1 to 7, show the construction of an elliptical chuck designed for milling elliptical holes with an ordinary lathe. The face of the chuck is a cast-iron plate 20 inches diameter, which, instead of traveling in a circle, moves in an elliptical orbit carrying with it the work to be drilled. The cutting is done by a small end mill mounted in the toolpost and driven by a belt from the countershaft overhead. Since the axis of the end mill remains stationary in reference to the center line of the lathe, but the work travels in an ellipse, it is evident that an elliptical groove will be formed, leaving a core which will drop out when the hole is completed.



Elliptical Chuck for Milling Elliptical Holes with an Ordinary Lathe.

Fig. 1 shows a front elevation and a horizontal cross section through the center of the spindle. Fig. 2 shows a cast-iron plate, *B*, which is threaded to fit the lathe spindle. The front side of this plate has a dovetail groove, one side of which is made adjustable for wear by means of the piece, *G*, shown in Fig. 7. The face of the chuck, *C*, shown in Fig. 3, is a cast-iron plate, planed smooth on the face and having a dovetail on the back to match plate *B*. The two blocks on the back of plate *C* pass (with considerable clearance), through the openings in the plate, *B*, as shown in Fig. 1. On these two blocks are fastened by capscrews the two steel blocks, *E*, shown in Fig. 5. These two blocks travel around the cast-iron ring *D*, shown in Fig. 4, as indicated on the sectional view in Fig. 1. The projecting lugs on this ring fit into the horizontal groove in the piece shown in Fig. 6. Fig. 6 is the only piece that is permanently attached to the lathe. The opening in the center is slid over the lathe spindle, and after being carefully lined up it is screwed to the headstock of the lathe. It is necessary that the horizontal groove be lined up parallel with the base of the lathe and at right angles with the center line of the spindle.

In placing the chuck on the lathe the piece in Fig. 6, with the ring in Fig. 4 attached, should be in position first; then plate *C* is carefully adjusted to plate *B*, which is then screwed on the spindle. Lastly, the steel blocks in Fig. 5 should be fitted close to the stationary ring so that they will travel around it without backlash. It is evident that when the ring in Fig. 4 is drawn away from the center, either forward or backward, the revolving steel blocks will cause the plate to travel in an elliptical path, the eccentricity of which will depend upon the distance this ring is set off center. The size of the ellipse is regulated by the cross feed or the distance the end mill is off the axis of the lathe.

* * *

SOMETHING ABOUT ALUMINUM.

EARL N. PERCY.

Engineers often ask: "What is the real value of aluminum. It is a pretty and interesting metal, but what practical uses can it be put to, and what does it cost?" This professional dubiousness is quite pardonable, as the most useful characteristics of aluminum are not entirely its lightness, nor does its lack of strength militate against it to any great extent. It can be purchased in blocks, ingots, pigs, bars of any section, sheets, wire, and in various manufactured forms. The prices in ingots quoted to date are: 99 per cent pure, 35 cents a pound; and 90 per cent pure, 34 cents a pound; the finished product varies according to the finish.

The metal can be readily welded by electricity; but soldering is an unsatisfactory process, since the greater conductivity of the metal removes the heat from the solder. The best aluminum solder is 80 per cent tin and 20 per cent zinc. This should be fluxed with a composition of 80 per cent stearic acid, 10 per cent tin chloride, and 10 per cent zinc chloride.

A pure nickel soldering bit should be used, as copper discolors aluminum This can be worked successfully if the aluminum be heated first, or kept hot with a blowpipe.*

Aluminum is 2.6 times as heavy as water, consequently will not float. It is 1-3 the weight of iron, and copper is 3½ times as heavy. It is 3 times the weight of good oak wood. It does not rust or corrode, except with strong alkalies or acids. Gold and silver, only, exceed it in malleability, it having been drawn down to a thickness of 0.0005 inch, and is most malleable between 400 and 600 degrees F. It has been made into tubes by the Mannesmann spiral process.

Aluminum stands next to copper in electrical conductivity. Taking silver as 100, aluminum ranks variously from 55 to 64. As gases are easily absorbed, aluminum should not be heated much beyond its melting point, 1,300 degrees F., and the shrinkage will be about 17-64 inch per foot. It, of course, will have to be melted in plumbago crucibles. As there are no aluminum oxides readily formed, the scums or oxidations will consist entirely of impurities, and will do more good than harm. It can be cast in dry or green sand, and the castings are about as strong as cast iron, running from 13,000 to 17,000 pounds tensile strength. Sheet and bar aluminum run about 26,000 pounds, and wire about 45,000 pounds. The wire has a specific gravity of 2.68, and an ounce of it can be drawn out 11,400 yards, to weight of only 0.042 grains per yard.

Pure aluminum is too soft and weak for most purposes, but it unites with all metals except mercury and lead, though with difficulty with antimony, and its alloys are very useful. Mixed with from 2 to 8 per cent of nickel it makes a valuable, hard alloy of tensile strength of some 50,000 pounds. Nickel-aluminum alloys have as much spring as the hardest of hard-drawn brass. Aluminum bronze, containing 5 to 11 per cent of aluminum, is a strong, fine-grained bronze, suitable for fine instruments. Copper-hardened aluminum has the strength of a soft bronze but the lightness of aluminum, and contains 2 to 15 per cent of copper. Aluminum steel is, next to nickel steel, the strongest steel made. Aluminum makes cast steel flow better and drives out occluded gases, making the metal more homogeneous.

Among the commercial uses of aluminum, none is more important than its application to automobiles, the bodies of which are made of laminated sheet aluminum, as are also the hoods and radiators. Many castings, formerly made of cast iron, are now made of aluminum alloys, while bronze parts wear just as well if made of aluminum bronzes. Crank cases, covers, glands, cylinder heads, etc., are made of aluminum bronzes or delta metals. Another very popular use is for open-air signs, because the metal never tarnishes or stains, and it makes pretty and artistic signs, the ductility of the metal making it possible to beat out beautiful and complicated designs. Aluminum dishes never stain or tarnish, and food cannot burn in them, because there is no rough surface or scale for it to stick to. For the same reasons, and also because of its great electrical conductivity, it is adapted to the construction of fine instruments, scales, electrical apparatus, and name plates. In connection with the latter, an imitation Cremona violin was recently exposed because of the aluminum name plate, which it would have been impossible for Stradivarius, or any other man in the seventeenth century, to have procured. Lamp shades, trimmings, clasps, visiting-card cases, and many other ornamental objects are now made of aluminum, for in spite of its cheapness, it has lent itself very well to the arts as well as being of great use in the engineering world.

* * *

MORE SHOP COST TROUBLES.

IAYONAC.

"I was right down tired of seeing the boys plodding along in the same old prehistoric way of doing things with never a possibility of improvement, and I had often kicked pretty badly when the superintendent got at me on figures." "See here," he would say, "here is an office cost of that pump job you did about three weeks ago. In my opinion that job cost about 70 per cent more than it should have done. I cannot understand just what you fellows are doing with your time up there, and let me tell you right here it has got to stop. The office has the laugh on you, and whenever they estimate on a job, you are bound to exceed it, hands down. What is the matter anyhow? Aren't your men all they should be, or don't you know just how the jobs should be done? I'm dead tired of all of you, and your ways of getting through work." The superintendent was referring to the brass-finishing department of which I was foreman. During all this talk I was getting pretty hot, and when he finished, and gazed into my face for the first time, the thermometer showed boiling point. "Now you are through," I gasped, "allow me to tell you that your scrap heap is just what you have made it. You know my opinion on that subject by heart, but you won't let me alter the state of affairs one durned little bit. And why? Just because it means sinking a few dollars to buy tools to bring the thing up to date. I tell you, the Boss hates machinery like snakes, just because it costs money to drive. You'd much rather see a fellow wearing himself out hacking down trees with a dull axe, or digging his grave with a hay fork, because you don't think he can earn his money unless he just wipes the sweat off his face all day long. May be you don't think I know you're way back in your methods, and perhaps you don't think I know that the jobs are costing piles more dollars than they ought to. For your edification let me tell you, sir, that you are fossilized and every man jack, from the boiler tender up, knows it, too. Send down your estimator, and I'll teach him his business—on shop costs, at any rate."

It was the superintendent's time to get hot, for he was not used to such plain talk. I had previously explained to him in a mild kind of way that we were woefully deficient in the matter of shop tools and that what we had needed patching up badly; that it could not be expected that we could turn out high-speed work on slow-speed machines that were furnished with broken gear and shaky slide rests; that where we used a file, other concerns employed a grinder; that the use of emery wheels would knock a big percentage off the cost of the work. "Now I want a three-spindle sensitive drill," I continued, "and I have here an estimate which will prove to you that I can save you the cost of this drill on one job alone. I want to quit chucking small jobs on the lathe faceplate. I want a sensitive drill mounted on a standard with just a simple lever feed motion, and, as we are now on the subject, I will be glad if you will make up your mind right here whether I get it or not." I placed the figures before him and we talked them over. "It seemed all right," he said, "and believed that amount of money could be saved." "Now I'll take you to the Boss and give you some idea of what it is like to get money in that direction."

The Boss was a gentleman who never appeared in the works, but managed the business from his office. His desk was furnished with a series of push buttons, each of which communicated electrically with the superintendent's and various other offices. He scorned the use of the 'phone, and the individual summoned had to appear before him in person. He hated machinery because it cost money, and because its intricacies were unfathomable to him. Also, he could never understand why a machine purchased fifty years ago should be obsolete to-day. The Boss was busy when we arrived. He was "fixed up" with the traveling man of a church window concern, and they were figuring up the cost of a stained glass window, to be put in the local church in memory of his wife, who was lately deceased. That over we were ushered in, and the subject of our interview was entered into without further delay. The matter of cost and the saving was explained to him, together with the alternative processes at present in vogue. Then the spirit of meanness entered into him. He made some calculations and inquired why a two-spindle drill would not do as well, and besides he did not altogether see the use of having a standard. "Why not cut that out, for that would cost more money, and put the drill on a bench?" I explained that the three spindles were a necessity as with two spindles the work would have to be handled twice, instead of once, and that meant both time and money. Anyhow, he

[* All known aluminum solders disintegrate by electrolytic action, the rapidity of the process depending on the conditions. Immersed in water, soldered aluminum pieces come apart in a few days.—EDITOR]

did not see why a one-spindle drill should not satisfy me, and with that remark, placed the whole of the papers into a drawer, where, I afterward learned, he sidetracked all other schemes for improvements. He "guessed the matter would have to lay over until such time as he could give his attention to the scheme, for it required some consideration." "In the meantime, my boy," he said, addressing me, "remember this, that God gave smart young men like you brains to devise means of producing work without the aid of tools or machinery." This struck me all of a heap and I backed out to explode outside. I told the superintendent I was right down sorry for him, but I hadn't a wife and family, and didn't have to stand the racket, and I reckoned I'd rather go out and cut grass with scissors than hang on to my job any longer than it took him to find another fool to fill it.

Some time after I quitted I heard that the Boss turned down the superintendent because he was leaning too much toward the boys. That drill scheme still remained in the drawer, and they went ahead with the job on the old lines, and had the usual racket on the cost. When the Boss says a thing the new man always answers, "Yes," and has his own thoughts on the matter.

* * *

A NOVEL PROCESS FOR TESTING LUBRICANTS.

DR. ALFRED GRADENWITZ.

On account of the noxious influence exerted by lubricating oil of a too liquid condition, the importance of having a means of controlling the consistency of the oil is self-evident, the more so as the viscidity of most oils will decrease rapidly and to a high extent for increasing temperatures. Besides the degrees of viscidity, the internal friction varies somewhat for different oils, being also influenced by temperature as well as by the difference in speed of the sliding surfaces. A small increase of the friction resistance on every one of the sliding surfaces may, in the case of extensive power transmission plants, including a large number of machines of low energy absorption, have a paramount importance for the total consumption of power and accordingly for the economic condition of the whole operation. Any oil used in such plants should, therefore, be carefully examined in this respect.

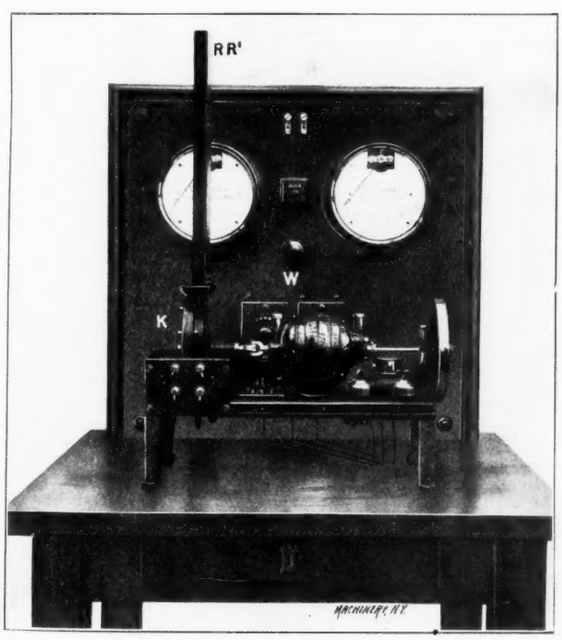


Fig. 1. Electric Heating and Speed Measuring Device.

In a new process patented by the Allgemeine Elektrizitäts Ges. Berlin, the amount of displacement of a liquid column at rest is used as a measure for the internal friction resistance of lubricating oil, other particles of the oil to be examined moving along at the foot of the column practically in the direction of the latter. The higher the friction resistance of the oil to be investigated, the higher will be the effect on the liquid column, so that the displacement obtaining for equal speeds will afford a simple method of measuring, susceptible of a ready comparison, for the internal friction resistance of different oils. In Fig. 2, *K* represents a closed compartment filled with the lubricating oil to be examined, and containing the flywheel, *F*, whose driving axle traverses the wall of the compartment. To compartment *K* are connected two vertical tubes, *R R'*, filled with the lubricating oil up to about half their height, thus forming with compartment *K* a system of communicating tubes. As soon as the flywheel is set rotating, the lubricating oil in the compartment surrounding the flywheel is compelled to take a part in the movement, there being on the path traversed by the circumference of the flywheel a friction of the moving liquid particles against those filling the foot portions of the tubes, *R R'*. The friction

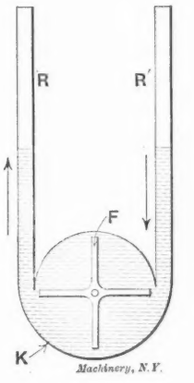


Fig. 2.

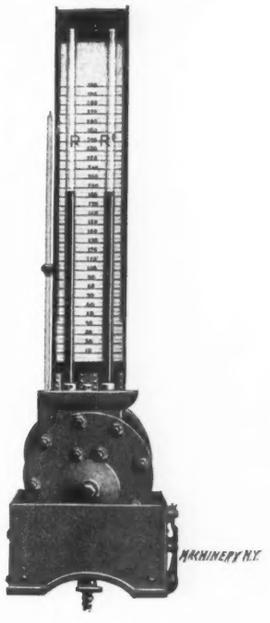


Fig. 3.

resistance results in the liquid column rising in one and falling in the other vertical tube. The level difference of the two liquid columns will accordingly, considering both its specific weight and the temperature of the liquid, afford a means of ascertaining the internal friction resistance of the lubricating oil.

In order to enable the lubricating oil to be examined at different temperatures, an electric heating device for heating the oil compartment, *K*, has been provided, while the controller, *W*, permits the number of turns of the driving motor to be varied within wide limits. The outfit further comprises a speed-measuring device, thrown in and out by means of electricity, as well as a voltmeter and an amperemeter, Figs. 1 and 3, the whole being mounted on a small table with switchboards.

* * *

In the discussion following the paper read by Mr. Frederick W. Winter before the Mechanical Section of the Engineers' Society of Western Pennsylvania on some facts concerning patents, the point was brought out that in patent law the product of a machine cannot be regarded as a part of the machine. As an example, a device for sugar-coating pills in a medicine factory was quoted, which consisted of a box connected with an air pump, the top of the box being perforated with holes somewhat smaller than the pills. The pills were distributed over the top of the box, one on each hole, and then by exhausting the air pressure within the box, the pills were firmly held in position so that the box could be inverted into the sugar-coating solution, but this device is not patentable *per se* for the reason that the product of the machine cannot be made an element of the claim of the patent, and it is said that the Patent Office has never recognized any exception to the rule. However, it is declared that the phraseology of a claim may be so worded as to evade the rule, inasmuch as it would not include the pill as an element in the claim.

SOME FACTS CONCERNING PATENTS.*

FEATURES OF OUR PATENT SYSTEM ABOUT WHICH INVENTORS SHOULD BE INFORMED.

The patent statutes of the United States are based upon Article 1, Section 8, of the Constitution, which provides that Congress shall have the power to promote the progress of science and useful arts by securing for limited times to inventors the exclusive right to their respective discoveries.

This constitutional provision gives the underlying principle of our patent statutes, and shows that the reward of the inventor is not the primary object aimed at, but it is a necessary incident. The framers of the Constitution perceived that the progress of science and the useful arts could best be promoted by furnishing an incentive to make improvements, and that the best incentive is some personal reward or advantage to the inventor. Accordingly an inventor for a certain period is given an exclusive right to his inventions and discoveries; that is, a monopoly. As a consideration he is required to describe and illustrate the invention in his patent specification and drawings so fully and clearly that a person skilled in the industry to which the invention relates can make and use the invention; to the end that after the monopoly has expired, the public will be able to use and derive benefit therefrom. Therefore an inventor applying for a patent must disclose his entire invention, the principle thereof, and the best manner of applying the same. He cannot withhold any part thereof; otherwise the patent will be void. If he wishes to keep the whole or any part of his invention secret, the patent statutes give him no aid. This statement is ventured because the writer has been asked to secure patents for inventions which the inventors did not care to disclose fully even to their attorney. Clearly all such efforts are futile.

What is Patentable.

The statutes provide for the grant of patents for new and useful arts, machines, manufactures, compositions of matter, improvements, and designs:

Art. The term "art" covers what are ordinarily known as methods or processes, where the improvement consists in the manner or mode of accomplishing the result, as distinguished from the mechanical appliances necessary for this purpose.

Machine. The term "machine" is self-explanatory.

Composition of Matter. The term "composition of matter" covers all mixtures of several ingredients, whether chemical combinations or mechanical mixtures. Soaps, powders, paints, etc., are examples of well-known compositions of matter.

Manufacture. A "manufacture" in the meaning of the patent statutes is anything made by the hand of man and which is subject to manufacture and sale. This term is a broad and elastic one, and the interpretation given to it by the courts bring within it all inventions which cannot properly be classified under the other heads.

Improvement. The term "improvement" in the statutes is largely superfluous, for in a sense every improved device is a new device; or, *vice versa*, most new devices are merely improvements over prior devices. In the history of our patent system there have been but few generically new devices or processes.

Design. The term "design" in the patent statutes has a different meaning from what it has in engineering, where it is often used to mean a new plan or arrangement of mechanical parts for getting new or improved functions. For instance, a new design of motor is a new motor. All such matters in the eye of the patent statutes are subjects for mechanical, and not for design patents. The term "design" in the statutes is limited to matters of ornament or configuration appealing to the aesthetic sense and not to utility; such as a new design for spoons, jewelry, vases, and the like.

Utility.

An improvement to be patentable must be useful. This does not mean that the device must be more efficient or economical than prior devices of the same character. It is useful within the meaning of the statute if it is capable of producing a result, and that result is a good one, even though it may not be an advance upon prior devices of the same kind. The degree of utility is not inquired into by the Patent Office. If a device is incapable of producing any result whatsoever, it is inoperative and not patentable. So, too, if the device is injurious to morals, health, or good order of society, it is not "useful" within the meaning of the patent statutes. Upon this ground the Patent Office refuses to grant, and the courts refuse to sustain, patents for deleterious compositions and compounds of food products and the like, and for devices which can be used only for immoral or unlawful purposes. The more completely such an invention could perform its functions the more objectionable it would be for want of utility If, however, a device is capable of a good result it is patentable, even though it may be used for some unlawful or immoral purpose. The evil in such case is not inherent in the invention, but is a fault of the user, for which the latter, and not the inventor, should be punished.

Subject to the exception in regard to the utility of an invention it is a general rule that all changes or improvements, whether mechanical, electrical, chemical, structural, or otherwise, in a method or process, tool, machine, appliance, device, manufactured article or composition of matter in all arts, are patentable, provided they are new and are the result of invention. The statutory classes of invention have been given a sufficiently broad and elastic interpretation to cover the whole range of human activities and industries.

Invention.

As to what constitutes invention no general rule can be laid down. There are many improvements which are the natural result of the advancement of an industry which are suggested by many persons whenever the occasion demands. There also are many changes which are merely the expected skill of an ordinary mechanic working in those lines. All such changes are not "inventions" within the meaning of the patent statutes, and are not patentable. In general, invention may be said to consist in bringing forth that which theretofore was hidden to persons skilled in that particular art. The amount of change necessary to constitute invention may be very small, or may be required to be quite radical, depending upon various factors, but principally upon the advantages and results following from the change. If the benefits are very great, and the public and manufacturers are anxious to adopt the improvement as soon as known, it will be held to show that even a very slight change was the doing of something which before was hidden, and hence to be an invention. On the other hand, where there is no marked resulting advantage, the courts require a greater degree of change in order to find the presence of invention.

Novelty.

The question of the newness or novelty of an invention is purely one of fact, and one upon which no opinion can be expressed without a detailed knowledge or examination of the art to which the invention relates. Under the statute, an invention is not new if it was:

1. Patented in this or any foreign country before the applicant's invention or discovery thereof, or more than two years prior to the application for patent;
2. Described in a printed publication in this or any foreign country prior to such invention or discovery, or more than two years prior to the application;
3. Known or used in this country prior to such invention or discovery, or
4. In public use or on sale in this country for more than two years prior to the application.

It follows that knowledge or use of an invention in a foreign country does not affect a patent granted in this country, unless such invention was either patented or described in some printed publication. Novelty can be determined only by an examination of all prior patents, publications, and uses in the same and analogous classes of inventions. This, to be thorough, covers a very wide range.

Term of Patent.

All mechanical patents are granted for the uniform term of 17 years. This is not now affected by the existence of any prior shorter-term foreign patents for the same invention, the only requirement being that if a patent is first taken out in a foreign country, the application in this country must be

* Abstract of address delivered by Frederick W. Winter before the Mechanical Section Engineers' Society of Western Pennsylvania, Dec. 1, 1904.

filed within twelve months after the filing of the foreign application. The term of seventeen years can be extended only by a special act of Congress, and this has not been done in any case, and is not likely to be done. In case there is a material error in the patent, or if it is inoperative or invalid by reason of a defective or insufficient specification or claim, it may be reissued, but such reissued patent will continue in force only for the unexpired term of the original patent. Design patents are granted for terms of three and one-half, seven, or fourteen years, at the option of the applicant. He must make his selection of the term at the time he files his application. It cannot be made thereafter.

The Right Granted by Patent.

All patents give an exclusive right during the term of the patent to (1) make, (2) use, and (3) sell the invention covered thereby. Infringement, therefore, may occur either by making, or by using, or by selling the device. Where one party manufactures a patented device, another party sells it, and a third party uses it, they are each liable for the entire infringement, and the patentee can choose which of the three he will sue, thus being able to select the one most able to respond in damages.

Patent rights extend to all of the United States and territories, but not beyond the same. *Vice versa*, patents granted in foreign countries give no protection in this country. Therefore it is no aid to the protection in this country to also take out patents in foreign countries. The seller or user in this country of an article manufactured abroad will be liable for infringement of any United States patent covering said article.

A patent gives an exclusive right only for that which is distinctly claimed. If no sufficient claim is made, the courts will give no relief, even if the invention is exceedingly valuable. The utmost care should therefore be exercised in drawing the claims of a patent. It is possible to so restrict the claims for a very valuable invention that it will be easy for others to devise forms of apparatus which accomplish the same result but do not infringe the patent. The claims should cover all possible mechanical embodiments of the principle of the invention, so that others, even though they originate new mechanical constructions or combinations, cannot avoid infringement.

Patent claims usually are drawn to combinations of the various elements which constitute the new device. Infringement does not exist unless all elements of the claims are employed by the defendant. In other words, the combination of a claim must be used in its entirety or else infringement does not exist. It is therefore essential that the claims, or at least the broad claim, should contain no element or limitation which is not absolutely essential to the principle of the invention. Brevity in patent claims is desirable.

Several Claimants for Same Invention.

It is never absolutely certain that a patent can be obtained until it is actually granted. Several parties may apply for a patent on the same invention, and in that case the applications will be put in what are known as "interference" proceedings, in which the parties will be required to take testimony to prove who is the first inventor, and the patent will be granted accordingly. The first inventor is the person who first perfected the invention and put it into a form capable of actual use, or, as it is technically known, "reduced the invention to practice." The best evidence of a completed invention is an actual commercial use thereof. But there is a rule that the filing of an allowable application for patent is a "constructive reduction to practice" and has the same force and effect in a contest on priority of invention as an actual commercial use.

While the general rule is that the first inventor is he who first reduced the invention to practice, an exception is recognized in favor of a party who was the first to conceive the invention, but the last to reduce it to actual practice, provided he was using reasonable diligence in perfecting and adapting the same. What constitutes reasonable diligence depends upon the particular circumstances of each case. The means at the command of a person, his employment, and other surrounding circumstances, his health, the complication of the invention, and cost of perfecting it, are all factors which enter into this question. What the law requires is reasonable, and not the utmost, diligence. But the Patent Office does not look with favor upon delays, and it requires a good excuse in all cases. The theory is that the party who first adapts an invention for actual use should not be barred by the stale claims of a prior conceiver who has slept on his rights.

Even after a patent is granted another party may file an application for the same invention and be put in interference with the patent. If he is able to prove, by evidence which does not admit of a doubt, that he first completed the invention, a patent will also be granted to him. The Patent Office, however, cannot call back or annul the patent first granted. It will merely be decided that the patentee was not the first inventor and a patent will be granted to the applicant. The Patent Office has no jurisdiction over a patent after it is granted except to declare an interference between it and a subsequent application, or to grant a reissue of the patent in case it is invalid or inoperative by reason of a defective or insufficient specification.

Patent does not Guarantee that Invention Can be Used.

The grant of a patent is no indication that the device covered thereby can be used without infringing prior patents. This is a point upon which much misunderstanding exists. Many persons assume that because the Patent Office grants a patent, the patentee has a perfect right to use the device covered thereby. This is an error. The Patent Office does not pass upon the question of infringement, but merely decides whether the applicant has made a patentable improvement over prior devices. Most patents cover mere improvements upon prior devices, and it frequently happens that there are still in force prior patents which cover fundamental principles of the device, and which will be infringed by the improved device, if the latter performs the same function by the same or equivalent means. To illustrate: The original Bell patent covered the fundamental principles of transmitting speech electrically. Within a few years thereafter, and during the life of that patent, others invented and patented many different forms of transmitters which were improvements upon the transmitter shown in the Bell patent. These improvements were clearly patentable; but they were just as clearly infringements of the Bell patent, because they of necessity operated on the principle covered by that patent. But in many arts to-day the existing patents are limited to such specific improvements that other improvements do not infringe.

All patents are *prima facie* valid. They may, however, be invalid for many reasons. The examiners in the Patent Office are human and liable to error. They also have not available the material for all grounds upon which a patent might be refused or invalidated. Patents can be refused upon publications or descriptions of the invention in scientific and technical journals or books in all languages. The Patent Office has not files of many publications, and many which they have are not available within the limited time in which the examiner must dispose of a case. So, too, a patent may be refused upon a prior use of the invention in some remote part of the United States, and which may be known to only a limited number of persons. Obviously, the Patent Office is not in a position to know of all uses.

There are, therefore, many elements entering into the validity of a patent upon which the Patent Office passes no opinion. A more extended examination through periodicals and prior uses than it is possible for the Patent Office to make, will frequently show, either that the patent is entirely void, or that it must be so restricted that infringement can be avoided.

Who May Obtain a Patent.

It is essential to the validity of a patent that it be granted on an application signed and sworn to by the original and first inventor or inventors, or by his or their executors or administrators. No other person, even with the consent of the inventor, can sign or swear to an application that will support a valid patent. The Patent Office has no means of ascertaining these facts and will necessarily be governed by the oath of the application. Should it, however, afterward develop that the party making the application was not the inventor, the patent will be invalid. The fact that a person furnishes capital, machinery, or material for developing the invention, gives him

no right to make or join in the application for patent. Such person may acquire an interest under the patent, but this can only be done by an assignment executed by the inventor and transferring to him the whole, or any fractional portion, of the entire right to the invention and to the patent. If such assignment is recorded in time the patent will be issued to the assignee or jointly to the assignee and the inventor, as the case may be. The builder of a new machine or device is not the inventor if he did not himself originate the ideas or principles contained in such device. In other words, an inventor may employ others to construct and mechanically perfect his invention without losing his exclusive right thereto, and without giving the mechanic who constructs it any right to the patent, unless it has been agreed upon by contract between the parties. Even in that case the mechanic will take his right only by reason of the contract and under a properly executed assignment. If a person conceives the general plan of an invention and employs another to construct and perfect the same, and the latter under such employment originates improvements which are included in, or, as the court said in one case, are ancillary to, the general plan, such improvements nevertheless belong to the person furnishing the general plan and can be included in any patent for which he may apply.

Patent Rights Between Employer and Employe.

Employes as well as employers are entitled to their own inventions and to patents granted therefor. This right can be modified by contract, but in the absence of a contract to the contrary an employe is entitled to a patent for any invention which he makes, even though it may relate to the business of his employer. If he develops the invention in the time, and at the expense, and with the tools and material of his employer, then the latter will have an implied license or shop-right to use such invention in his business, but he cannot demand an assignment of the patent. Employers who wish to secure inventions relating to their own business, which are made by others while in their employ, should have a contract with the employe. Even with such a contract the employer cannot apply for a patent in his own name, but the patent must be applied for by the employe and assigned to the employer.

Joint Owners of Patents.

Patents may be owned jointly by two or more parties, and these may have different fractional interests. A common misapprehension is that one joint owner of a patent cannot make, use, or sell the patented invention without the consent of, and without accounting for profits to, his co-owners. This is an error. In the absence of a contract to the contrary, any co-owner of a patent, no matter what fractional interest he may hold, is free to assign his interest in the patent, or to manufacture, use, and sell the patented device, or license others to do so, without the consent of his co-owners and without accounting for any part of the profits. If, therefore, a person owns merely a one-hundredth share of the entire patent right, he may manufacture, sell or use the patented device without the consent of, or accounting for the profits to, the owners of the other ninety-nine one-hundredths. By reason of superior facilities for manufacture, or superior business ability, he may even entirely monopolize the field so as to practically exclude his co-owners from deriving any income whatsoever from their share of the patent. He is nevertheless entirely within his right. The only way this can be prevented is by a properly drawn contract between the co-owners.

Application for Patent.

Only a small percentage of patent applications are allowed as first filed. Generally the officials find some objections against the specification or claims, generally the latter. It frequently happens that a patent is not secured until after repeated considerations. An inventor should therefore not be discouraged because in the first instance his application is rejected. The rules give ample opportunity for overcoming rejections either by amendment or argument, or both, or even appeal to a higher tribunal. But no new or additional matter can be incorporated in an application after it is filed.

Marking Patented Articles.

The owner of a patent must mark the patented articles plainly with the word "patented," or similar word, together with the date of the patent, or otherwise give sufficient notice to the public that the device is patented. The failure to so mark will prevent the recovery of damages for infringement occurring prior to actual notice of the patent to the infringer. No person should mark an unpatented article with the word "patent" or other designation which would leave the public to believe that the article is patented. For each such false marking, with intent to deceive the public, the marker is liable to a penalty of $100. While the application is still pending the manufactured articles can be marked "patent pending" or "patent applied for." This will warn the public, and in most cases will prevent infringement.

Caveat.

There is a common misapprehension that a caveat is a short term patent. On the contrary it is a mere notice to the Patent Office that the party has made an invention and wishes further time to mature the same. It continues in force for one year, and it may be renewed from year to year by the payment of the required government fee. If during the term of the caveat, or any renewal thereof, another person files an application for patent for the invention shown in the caveat, the caveator will be notified thereof and will be required to file his application within three months from the time of receiving the notice. The two applications will then be put in interference and testimony will be taken to prove who was the first inventor, and the patent will be granted to such party.

Foreign Patents.

The patent laws of no two countries are the same, and a device which is patentable in this country may not be patentable in foreign countries, and, *vice versa*, devices which are not patentable here may be patentable in some foreign country. In Germany it is difficult to obtain patents, the laws and their interpretation being very strict. Many of the small improvements which are patentable in this country find no favor under the German law. In other foreign countries, notably Belgium and France, no examination into the novelty or patentability of the invention is made, but the patent is granted as a matter of course. But this does not mean that the patent will be held valid, as it may be overthrown if it is found that the invention was not new in that country at the time the application was made. It is essential, therefore, in these countries that the prior state of the art be thoroughly investigated before the patent claims are drawn.

The cost of obtaining a patent in most foreign countries is greater than in the United States, and the conditions of maintaining the patent are somewhat burdensome. In this country, no taxes or renewal fees are necessary, nor is the patentee even compelled to manufacture the patented device or put it into use. In most foreign countries the patents are subject to annual taxes or renewal fees. These vary in the different countries, being generally quite low the first few years of the patent term, but gradually increasing. Such taxes amount to a considerable sum in the aggregate, and if the patent is not producing a revenue they are a burden. So, too, in most foreign countries the inventor must put the invention to actual use in that country, or at least make such arrangements for manufacturing and so advertise the fact, that any person wishing to procure the patented article can be supplied. The manufacture of the articles in this country and importation into foreign countries does not comply with this provision of the laws of those countries.

In most foreign countries patents must be applied for before corresponding patents are issued in this or any other country. Canada is an exception, as patents can be applied for within a year after the issue of a patent in another country.

* * *

The importance of the rubber industry in the United States is indicated by some figures published by the Bureau of Statistics, which show that during the year 1904 nearly 62,000,000 pounds of india rubber were imported, of which 34,500,000 pounds came from Brazil. This importation is valued at $44,000,000, or 70 cents per pound, the price having increased to this figure from 43 cents, the price in 1884.

PUNCHING SMALL HOLES IN TOOL STEEL BLANKS.

JOSEPH V. WOODWORTH.

Joseph V. Woodworth.

The tools described herein and illustrated by the accompanying drawings were used for the punching of five holes 0.050 inch in diameter through tool steel 1-16 inch thick. Now it will be conceded that the accomplishment of this work presented unusual difficulties, the exceedingly small diameter of the holes in comparison with the nature and thickness of the material worked upon precluding the use of tools of standard design and construction.

Fig. 1 is an illustration of the two parts for the piercing of which the tools were used. As will be seen from the black dots five holes were punched in each. The part shown at the right is a small dovetail piece of tool steel which is afterward riveted to the part on the left, thereby forming a slide which is used in a machine of world-wide use in printing and publishing concerns. After assembling by riveting, the article is hardened, tempered, and ground, and the dovetail surfaces are shaved to accurate measurements, the allowable limit of variation being only 0.0005 inch at any point.

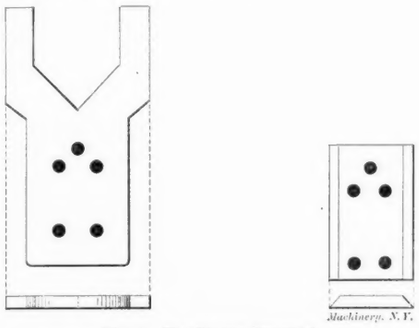


Fig. 1. The Pieces Punched.

Fig. 2 shows three separate views of the upper or punch section of the tools. The construction is such as to overcome as much as possible the tendency of such frail punches to buckle, snap off, or shear the dies, and is as follows:

D is the holder of machine steel in which are located and fastened the five punches, *A*; *E*, the adjustable backstop, for the punches to bank against; and *G*, the two die-aligning studs. *C*, the punch-supporting pad and stock-stripper combined, has five holes let through the face *B*, into which the punches fit snugly. Five filister head screws, *K*, fasten the punches in the seats in the holder. Two studs, *G*, are fastened and located in *D* in accurately-reamed holes by the two headless screws, *H*. Eight small coil springs—four of which are shown—located in countersunk seats in the holder and punch-supporting pad, keep the pad, *C*, tightly against the blank while the holes are being pierced; they also cause it to strip the blanks after each stroke. It will be seen that the construction of the punch throughout is such as to insure a perfect alignment with the dies, and to give a stiff and positive support to the five punches up to the point where they enter the stock. The two shoulder screws, *J*, prevent the combined supporting pad and stripper, *C*, from descending too far.

The lower section—the die—is shown in Figs. 3, 4 and 5. Figs. 3 and 4 are plan and side views respectively; and Fig. 5 shows a vertical cross-section. The construction is interesting.

JOSEPH V. WOODWORTH was born in Brooklyn, 1872. He received a high school education in the evening schools of Brooklyn, and took a mechanical engineering course with the International Correspondence Schools. He served an apprenticeship with the E. W. Bliss Co., and has worked for a number of the best die-making and special machinery manufacturing establishments in New York State, with which he has held the positions of tool-maker, die-maker, designer, foreman, and master mechanic. He is now holding the position of consulting engineer and reducer of manufacturing costs with the Mergenthaler Linotype Co., Brooklyn, N. Y. Mr. Woodworth has contributed many valuable articles on die-making and interchangeable manufacturing to MACHINERY and other trade papers, and has written three books, viz.: "Dies, their Construction and Use," "Hardening, Tempering, Annealing and Forging Steel," "American Tool Making and Interchangeable Manufacturing."

L is a bolster of machine steel, *R* the die in which the five piercing dies are contained and which are indicated by the black dots in the plan view. The manner in which this die is fastened and located within its seat in the bolster so as to remain positively fixed is shown clearly in Fig. 5. A keyway

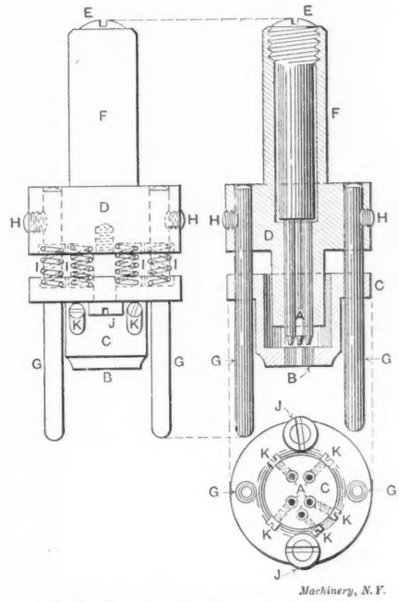
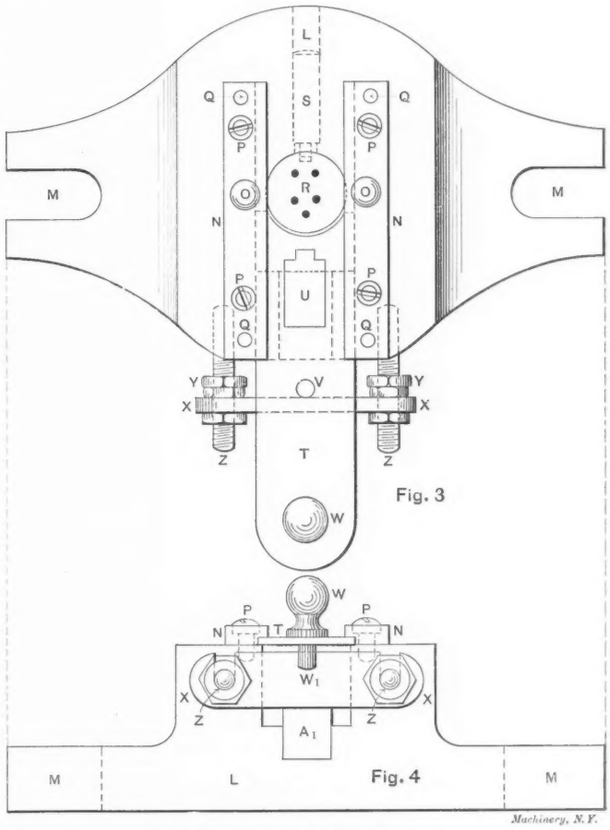


Fig. 2. Construction of the Punch Holder.

is let into one side of the die, *R*, which is engaged by the key-ended stud, *S*. The hole, C_1, in the bolster, is tapped from the under side for the greater part of its length for the hollow headless screw, B_1, upon which the die, *R*, rests. Thus, when it is necessary to grind the die face of *R*, the headless set-screw, B_1, is utilized to force the die to a height even with the surface of the bolster.

Returning to the views, Figs. 3 and 4, *N* are two tool steel gibs in which the slide, *T*, for locating the work on the die



PLAN AND SIDE ELEVATION OF DIE

Figs. 3 and 4

face, moves. These gibs have reamed holes at *O* for the punch aligning studs, *G*, to enter. The gibs are fastened and located on the bolster by means of four screws and four dowels, *Q*. *X*, *Y*, and *Z*, indicate parts of the adjustable stop which serves to adjust and fix permanent the movement of the slide, *T*. *W* is a small knob which the operator utilizes when working the slide back and forth during the punching of the holes. *V* is the stop-pin which prevents the slide from coming out too far from the gibs; and W_1 is the pin which prevents it from moving in beyond the proper locating point for the blanks.

When the tools are in operation the punch is set so that the two aligning studs, *G*, are in the holes, *O*, in the die gibs. The die is clamped in position, and the stroke of the press is regulated so that the aligning studs, *G*, do not leave the guide holes during the up-stroke of the ram. The operator then slips one of the small blanks shown at the right in

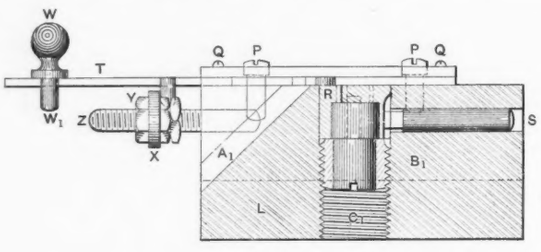


Fig. 5. VERTICAL CROSS SECTION OF DIE

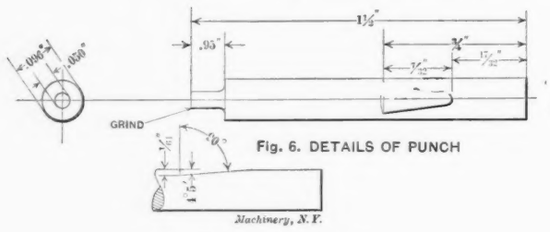


Fig. 6. DETAILS OF PUNCH

Figs. 5 and 6.

Fig. 1 into the locating seat, *U*, in the slide, *T*, pushes the slide forward until the pin, W_1, rests against *X*, and then he steps the press treadle. On the up-stroke the work is stripped from the punches by *C* and remains in *U*. The operator pulls the slide back, and the blank drops into the exit chute indicated at A_1 in Figs. 4 and 5.

Fig. 5 shows detail drawings of the punch. These punches are made in lots of five hundred at a time, from drill rod of the exact diameter of the punch shanks; a small accurate box tool in the screw machine turret reduces the punch ends to size.

Over 100,000 blanks of both shapes shown in Fig. 1 are used per year in the works where the tools shown are used. To use the tools for punching the five holes in the larger blank shown at the left in Fig. 1, a different slide is substituted for the one used for the small blank.

* * *

THE USES OF HIGH-SPEED STEEL.

G. H. B.

The writer has taken a good deal of interest in the method of using, treating and grinding high-speed steels. The first thing is to make up one's mind as to the quality or kind of steel to use, which means to be satisfied with the steel which has been found to work best in one's own shop. This has been a difficult matter for superintendents and foremen to decide, because it is so hard to discover the best way to determine which steel will do the most work, and experience has taught most of us that any of our high-speed steels, when properly treated, will do considerably more work than the machine is capable of.

I do not think it advisable to have too many different kinds of stock in the works; results depend entirely upon the way of forging and treating the tool. If the toolmaker is familiar with one or two grades of the best high-speed steel, and the quality is found satisfactory, and bringing about the best results that the machines can stand up to, these are the steels that should be adopted. Each of these steels must be treated differently, and if the toolmaker succeeds in treating one grade properly and understanding it thoroughly, it means much time saved and better results in the shop.

In introducing the use of high-speed steel in a shop, like everything else that is to be a success, one must start right. That is, the work should be undertaken by some responsible person—superintendent, foreman or speed boss, in other words, the man who is responsible for the work turned out in the machine shop. All tools, of course, have some particular way of treating, which should be understood by the person in charge. Now it is "up to the forger." The person in charge should see that the tool has its proper treatment, as success in most cases lies with the treatment. When the tool is finished, and the superintendent or foreman is satisfied that it has been properly treated in accordance with directions, it is ready for grinding and for making a test. It should be ground on a wet emery wheel, and care taken to heat the tool just so it can be touched with the fingers.

The tool once ground and ready to do the work, the question often arises, "What lathe, planer or machine are we going to put it into?" In most cases when a new tool is tried, it is put in a lathe, to do turning; so naturally the superintendent or foreman would pick out the best lathe that was in the shop, *i. e.*, the lathe that was considered to have the most power. Being now ready to make the test, it is generally tried on steel; that is considered by most superintendents and foremen the severest test to make. Take a piece of steel of almost any diameter, and of the quality most used in the shop, and prepare to take the cut. It seems to puzzle most every foreman to know just what to do and where to start. I speak now of what I have seen, and of the men who are sometimes sent by the steel makers to demonstrate the use of their steels. I think the proper way is to get at least one dozen shafts of a standard size that are used in the regular line of product, and to first look up the exact time it took to finish or rough off the previous lot; then to determine about what percentage of time would be considered a fair gain to warrant adopting the steel, based on the price per pound of the steel being used. Let it be based at 25 per cent, which I find in most shops can be accomplished, and the lathe be speeded up faster than when the last lot was turned, starting with the same feed and about the same cut, which most any lathe will stand. The superintendent finds, after he has roughed off about two or three pieces, that the tool seems to stand up all right. The next step is to find out about the speeds and feeds. The first thing is to increase the feed with the same speed the machine is running at. In most cases which I have seen, after the tool had traveled a certain distance the cutting edge would break or crumble, and the foreman would say, "Just as I expected. All this high-speed steel will do the same thing," forgetting he had just been doing over 25 per cent more work than ever before, without the least bit of trouble.

Now the tool is taken out and looked over, and it is found that a portion of its cutting edge has been broken off. Here is where most foremen make a mistake; they take the tool back to the forger or tool dresser to have it re-dressed and treated over. If it is only broken off slightly and can be ground, even if it take ten or fifteen minutes to grind, it should be done by all means. My experience has taught me it will prove a better tool than before, but care must be taken not to overheat in grinding.

The tool is now put back in the lathe, which is started again; and generally, to one's astonishment, it will be found that the tool will stand up all right. One should not be too anxious to break the tool again (!), but should turn up two or three more pieces with an increase of feed, keeping a record of the time it takes to turn up each piece. Once convinced that the tool will stay up all right with the increase of feed, the foreman can increase the speed one step on the cone. About the time this is done, it is found either that the belt slips, the lathe is stalled, or the countershaft will not drive. (It is my opinion that in most all machines which have been built up to a year or so ago the countershafts are not strong enough in comparison with the machine tools.) Now, no doubt if these things had not occurred the tool would have

done better; but in this case, reduce the speed, and finish the twelve shafts, which it will probably be found can be done without grinding the tool. When the shafts are all roughed off and finished, the foreman will find to his great astonishment that by actual time the lathe has produced over 25 to 40 per cent more work than ever before. I allude to the lathe using most all ordinary tool steels.

At this point it is up to the superintendent to see just where he is at, and he finds in looking around his shop that there is hardly a machine that he can't speed up, but he also finds that the speeds on the countershafts are all too slow. This means that he has either got to increase his speed by increasing the main line, or buy new pulleys to increase his countershafts. In most instances it is advisable to increase the speed of the countershaft, but by doing this he generally finds that the countershaft will not stand the speed. If the machines are not too badly worn out, and he is satisfied that he can get at least 25 per cent more work out of the tool by increasing the counter speed, by all means let him get a new countershaft and treat each machine this way.

No doubt the readers of this article will know the results that some of us have arrived at in the last two years. In regard to cutting speeds and feeds there has been and always will be difference of opinion, and it is almost impossible to determine the right feeds and speeds, whether it is for steel or cast iron, and for the operations of turning, planing, or milling. The work varies so in different shops; that is, regarding the construction of different pieces, the amount of metal there is to remove from each piece, and how accurately the work has to be done.

There is no doubt in my mind that the makers of high-speed steel have awakened the management of different shops, and it is surprising the amount of work which can be accomplished even with the old machines, with very little redesigning. There is no question but that the machine shops which do very heavy work have not the necessary power for the use of high-speed steels, as the power should be used if the machines are old ones. Referring again to the question of grinding, I wish to state that this is a very important factor in the use of high-speed steels. I have seen much damage done to the tools, in many instances making it necessary to treat them over, and as we all know, this takes much time. My recommendation for grinding is to let one man grind all the tools, and be responsible for them. When a lathe hand or a machine hand wants his tool ground, he simply gives it to the man who is responsible, and gets another the same size and shape, these being always kept ground and ready for service. In this way the tools are kept uniform and ground alike.

In reference to the amount of work that can be accomplished on different machine tools, the writer finds that the feeds have been altogether too fine on most makes of machines up to the time that they were redesigned for high-speed work. Now it has been demonstrated that high-speed steel has come to stay, and we all know that it works better on roughing work than it does on finishing. If most of the product of the machine department is to be turned, it has come to the point where the majority of work must be ground; and this is the only way to get good and accurate work, especially where the strains of the cut spring the work. Moreover, as it is not necessary to straighten the work to any great extent, it certainly means a great saving, as many of our readers know. The writer is not a builder of grinders, but merely speaks of the saving it has been on his own work.

Below is a fair average of the speeds that most any good make of lathe, planer, drill press or radial ought to stand when using high-speed steel. Every lathe has a faceplate about the diameter of the swing or very near that. Take the periphery speed of same by feet per minute; the use of a Warner cut-meter will give you the speeds instantly. This is one of the handiest little tools that can be obtained, and no machine shop is complete without it. The speed must be taken with the belt on the largest step of the cone, with the back gears in. The speed of the following sizes of lathes, taken from a large faceplate with the slowest speed, I find to work very well, and considerable saving has been effected even on old lathes. Of course the feeds will have to be determined by the amount of power available:

LATHES.

14″	swing	lathe;	slowest	speed	with	back	gears	in,	100	feet.
16″	"	"	"	"	"	"	"	"	90	"
18″	"	"	"	"	"	"	"	"	85	"
20″	"	"	"	"	"	"	"	"	75	"
24″	"	"	"	"	"	"	"	"	65	"
30″	"	"	"	"	"	"	"	"	60	"
36″	"	"	"	"	"	"	"	"	50	"
42″	"	"	"	"	"	"	"	"	30	"

Larger lathes in proportion.

PLANERS.

20 x 20	travel of cut,	40	feet.	
24 x 24	"	"	38	"
36 x 36	"	"	35	"
48 x 48	"	"	30	"

Larger ones in same proportion.

If you have the power in your planers the speeds ought to work on soft steel as well as cast iron.

High speed twist drills, drilling cast iron, ought to drill the following, if you have the power and feeds:

½″	diameter,	speed	500	r.p.m.,	3¼″	deep	in	one minute.
⅝″	"	"	400	"	2¾″	"	"	"
¾″	"	"	335	"	2½″	"	"	"
⅞″	"	"	290	"	2¼″	"	"	"
1″	"	"	250	"	2¼″	"	"	"
1⅛″	"	"	220	"	2⅛″	"	"	"
1¼″	"	"	200	"	2″	"	"	"
1⅜″	"	"	185	"	1⅞″	"	"	"
1½″	"	"	175	"	1¾″	"	"	"

Larger ones in proportion.

These speeds are all based on a periphery speed of 65 feet per minute. High-speed drills have done somewhat better than this, however, but taking into consideration the time of grinding, I find that this speed is a good average during a day's run.

* * *

OF HISTORICAL INTEREST.

We have received from Wilfrid B. Ward, Richmond, Ind., a brief but interesting account of his grandfather's old shop in Philadelphia, built in the latter part of the eighteenth century, which we publish below:

Mr. Thomas Barritt (my grandfather) served an apprenticeship between the years 1792 and 1797 with John Stowe, who had a shop on Bread Street, near Second, where they did wood turning, also turning in iron. Later, after he had finished his apprenticeship he married his employer's daughter and set up for himself in a shop on Front Street, between Vine and Callowhill, where he took up the turning of metals and apparently did a good business. In 1804 he invented a threshing machine for grain for which he received a patent in 1804 which bears the signatures of Jefferson, President, and Madison, Secretary of State. In 1822 he invented a machine for tarring ship cordage, for which he was presented with the John Scott medal by the "Philadelphia Society;" also a machine which we think was the first mineral water machine. This he took to Washington and it proved a complete success. He also brought out a machine for finishing silk hats, for which invention he was rewarded by having his house mobbed by the men whom it threw out of work. He turned the capstan of the first 74-gun ship that left the navy yard, and I have a record of some large screws turned for the water works in 1810.

He constructed the Readhefer perpetual motion machine which took up about all the space the old-time magazines had to spare; at least my old books seem to have devoted a great many pages to a discussion of its merits.

Mr. Eschol Sellers, in a letter written a few years ago, mentions my grandfather's shop, but he was only a boy at that time and did not remember much about it. I have a receipt of Jacob Frick for brass castings, amount $56.40; so I presume he ran no foundry in the year 1830. Also an account of the laying of water pipes in New Market Street in 1826 for which his amount to pay was $27.50 for 34 feet. Mr. T. Bryant was water works superintendent at that time.

* * *

Bells are cast of a mixture of three parts copper and one part tin. It is said that the bells of old Nineveh were of this composition, which, if true, would make the formula almost as old as the known history of man.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

One of the doubtful joys of an editorial position on MACHINERY is answering the questions of correspondents. While there is always a decided satisfaction in imparting information of which you are reasonably sure, or of which verification can be found in some so-called authority or work of reference, the trouble with answering the questions propounded by MACHINERY readers is that they are usually far beyond the kindergarten class, and the answers are more or less uncertain unless one has had special experience on information in that particular line. There is, however, no better sharpener of wits than the searching out of information of a definite character, even if it is of comparative inconsequence, and for this reason we welcome all the questions that may come, being assured that we will derive fully as much benefit from the labor incurred as will the correspondent in the answer received. Therefore, come ahead with your questions, and we will "make a fist" at answering anything that directly relates to the mechanical interests of the majority of our readers. Incidentally, we cannot help being impressed by the lack of information on a variety of subjects and the poverty of many mechanical works when it concerns other than what might be called the academic side of mechanical engineering. Therein lies the great difference and value of a publication like this, which, while necessarily behind the "state of the art," follows it much more closely than can any book.

* * *

OUR RECORD OF NEW TOOLS.

In the department "Machinery and Tools," which appears in our columns each month, will be found the most complete and convenient summary of new appliances for the machine shop that appears in any publication. The items in this department are used strictly because of their news value and not because of any advertising consideration. It is our purpose to list and, in many cases, to illustrate new machine shop products when they are placed upon the market, for the convenience of purchasers of such machinery. The amount of space and the number of illustrations accorded to any machine depend, as a matter of course, first upon the novelty of the machine, and second, upon the completeness of the information sent to us. It would not be of interest, for example, to show a number of illustrations of a lathe which, in the arrangement of its parts, was substantially a standard article, similar in its essential features to what had been manufactured for many years. When a machine is more or less of a standard character, the best that can be accomplished by our department is to give a general view of the machine, showing what its appearance is, and to accompany it by a few brief specifications, sufficient to convey to the reader an idea of the machine's proportions and of the work that it is able to do. The illustrations used in such articles are made as small as is consistent with the details of the parts appearing in the illustration, the size depending also somewhat upon the appearance of the printed page on which the engravings are arranged. It obviously is not possible to make the different machines appear in their true relative proportions; as for example, a boring mill and a surface gage, which could not be assigned space corresponding to their dimensions. We have sometimes received complaints because such and such ones have had larger engravings than others, and while we undoubtedly err occasionally in proportioning the sizes of engravings, we think the average reader will understand that the size of the cut is intended to be no criterion of the value of the machine. We simply aim to publish a concise illustrated record or list of new products, arranged for convenient reference, and if this department of the paper accomplishes this end it will fulfil its mission.

* * *

A MAN'S BRAINS ARE HIS OWN.

The courts do not look with favor upon such contracts with employes for inventions as can be construed as "a mortgage upon the man's brain." For this reason when a contract is made between an employer and an employe by which the former is given rights in the inventions relating to his business that the latter may make, it is necessary, in order for such contracts to be sound and valid, for it to be very carefully drawn, and its scope must be accurately defined; it must state what particular inventions are to be the property of the employer, and it should also state what compensation is to be given the employe. While wages or a salary might be considered as a compensation, it is not generally so considered by the courts, unless it can be shown that such wages include an extra allowance which is regarded as compensation for the inventions made by the employe, or that the wages are paid the inventor as such and not as an ordinary workman. In other words if a man is hired as an ordinary draftsman and during his period of service he makes an invention relating to his employer's business which is not incorporated in the results of his regular work his employer has no claim on it. But if he is hired as a draftsman to plan, devise and improve the machines the complexion is changed. A contract which includes all past, present, and future inventions would be invalid, or if it is for "all inventions which the employe may make" it would not be sufficiently specific. But if Jones is building a line of shoe-making machinery, he can contract with Smith to improve this machinery, and all inventions that Smith shall make during his period of service relating to shoe-making machinery would properly be the property of Jones. If during this period, however, Smith should invent an electric motor, Jones would have no claim whatever upon it, provided Smith could show that this invention was made and developed outside business hours. On the other hand, if he developed the motor and made the drawings in Jones' office, and received pay for the time spent in doing such work, Jones would have shop rights in the invention, but no control of it outside of his shop.

* * *

Certain features of interest in regard to the Panama Canal and the work now in progress on the Isthmus will be found in another column, in a report of the last monthly meeting at the rooms of the American Society of Mechanical Engineers, at which Mr. W. R. Warner, of the Warner & Swasey Co., and Prof. Burr, of the Panama Commission, gave interesting talks. It may be added in this connection that any mechanics who wish to seek employment at Panama during the construction of the canal can obtain full particulars as to conditions, examinations, vacations, transportation, etc., by applying to the Civil Service Commission, Washington, D. C. The employment of help on the Isthmus has been placed under civil service regulation and will be on the basis of competitive examination.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Prof. William G. Raymond, of the University of Iowa, has prepared data showing conclusively the tendency from arts to engineering courses in American colleges. From the attendance rolls of eighteen leading colleges, which offer both engineering and arts and science courses, it appears that the attendance in arts and science has increased in four years 15 per cent, and in engineering, 102 per cent. These figures include only regular students, and the record for the arts and science attendance includes many women students.

Various metals which are themselves non-magnetic may form alloys which display magnetic qualities; some of these have been produced in recent experiments. Aluminum, copper and manganese are all non-magnetic, but when combined in certain proportions an alloy of considerable magnetism is produced. As no alloy of copper and aluminum alone is magnetic, this effect must be ascribed to the manganese, and yet this metal alone, as well as copper and aluminum, remained non-magnetic when cooled to the temperature of liquid air. An alloy of manganese with iron is practically non-magnetic, but with the same manganese a magnetic copper alloy can be made.—*Engineering Review.*

New York City is shortly to embark in an interesting experimental enterprise, namely, an attempt to run a crematory in connection with an electric lighting plant. In Great Britain, we are told, city refuse has been used successfully for steam raising and also in Hamburg, good results having been obtained from a combined destructor and electric plant, but in this country no practical data have as yet been obtained. Hence original designs will largely have to be gotten up for the New York plant, which fortunately, perhaps, will be on a comparatively small scale. In all probability an attempt will be made to combine refuse and coal in some proportions, or to depend for steam partly on coal as well as on refuse. This experiment will be watched with great interest.

The problem of rapid rail wear on sharp curves is a serious one with the Boston Elevated Railway on which line there are eighteen curves of less than 100 feet radius, and sixteen other curves of less than 150 feet radius in a total of sixteen miles of track. On one curve of 82 feet radius an ordinary commercial steel rail weighing 85 pounds per yard lasted only 44 days, the wear in that time being 0.6 to 0.77 inch, according to the statement of Mr. H. W. Steward in a paper read before the New England Street Railway Club at Boston. Nickel steel rails were next tried, but these wore at the rate of 0.53 inch in 204 days. Manganese steel rails are now being used, and the wear in 1,000 days has been a little less than 0.2 inch. Manganese rails are very costly, the first cost being about $5 per foot, as against thirty-eight cents for ordinary steel. Manganese steel can be bent cold but cannot be cut cold with ordinary track tools.

The three great power stations now being built on the Canadian side of Niagara Falls will have an aggregate output of 285,000 H. P. In addition to the above, the Ontario Power Company intends increasing its power ultimately by 120,000 H. P., so that the total output for the new Canadian stations will then be 405,000 H. P., which is more than 27 per cent of the world's present hydro-electric power, computed at 1,483,000 H. P. On the American side there is about 150,000 H. P. in the three stations. On the Canadian side, along the old Welland Canal, there are two stations having at present 26,000 H. P., with a total planned for of 52,000. The total for the district will then be over 600,000 H. P. While it is said that the Niagara Falls region is not likely to make use of more than 400,000 H. P. for at least a generation to come, still this amount is sufficient to play a very important part in industry, whatever its effect may be upon the grandeur of the Falls.

A new incandescent lamp in which the incandescent filament is tantalum, a rare metal, in place of carbon, has been produced as the result of two years' experimenting at the Siemens & Halske Electric Works in Germany. The tantalum, which has to be worked in vacuum, is somewhat harder than mild steel and has a tensile strength considerably greater. Tests have resulted in a commercial form of lamp which takes 1.7 watts per candle power as compared with three or four watts per candle power with the ordinary carbon filament. In order to get sufficient resistance for a 110-volt lamp, a filament 2½ feet in length has to be used. This is mounted by running the tantalum filament back and forth between a lower and an upper star-shaped support, so that the lamp is not much bigger than the carbon filament lamp. The incandescence is high, so that the light is very white. The average useful life of the lamp is between 400 and 600 hours. No figures are yet available as to the first cost of the lamp, but if it can be manufactured cheaply enough, its great gain in economy over the carbon filament lamp should lead to its widespread adoption.

According to the authority of Mr. J. M. Gledhill, of Armstrong, Whitworth & Co., ordinary crucible steel containing 1.30 per cent carbon is suitable for small turning and planing tools, drills, small cutters, razors, and surgical instruments; 1.15 per cent carbon for heavier turning, planing and slotting tools, drills, cutters, reamers, and engraving tools; 0.90 per cent carbon for large circular cutters, reamers, taps, dies, heavy turning tools, and large drills; 0.80 per cent carbon for cold chisels, hot sets, small shear blades, and large taps; 0.75 per cent carbon for dies, cold sets, hammers, swages, minting dies, miners' drills, blacksmiths' tools, punches, and shear blades; and 0.65 per cent carbon for snaps, dies, drifts, hammers, and stamping dies. The steel that is suitable for making a razor is obviously totally unfit for a stamping die, although it is of much higher grade and more costly. Much of the trouble encountered in the average shop in the use of tool steel is that no record is kept of the carbon content of the various steels kept in the tool room, and very often an entirely too high grade steel is used for a purpose where one of perhaps half the carbon content would be much better suited. Some shops paint one end of all steel bars in colors and combinations of colors which correspond to an arbitrary classification. As these bars are used, the stock is cut off the opposite end, and the marked end remains until the bar is completely used up. Where this or a similar system is employed, a large part of the trouble of the toolmaker should be avoided.

When a coiled spring is mounted on a mandrel which fits it closely, it can be made to grasp the mandrel with great force by turning the opposite ends of the coil so as to close upon it. Advantage of this fact is taken in the design of a shaft coupling which makes unnecessary any keyways cut in the shaft. It is also used in the coil-clutch reversing gear used to some extent in rolling mills. The ordinary type of rolling mill requires that the engine be of the reversing type, and when the limit of rotation in one direction is reached the rolls are reversed by reversing the engine. This means that the valve gear must be of a simple type operated by link motion, and prevents the use of a more economical form of valve motion like the Corliss type. By the use of the coil-clutch reversing gear, the engine runs in one direction all the time, and therefore can be of the compound condensing type of high efficiency. The clutch includes two steel coils surrounding drums keyed on the shaft which has to be reversed. The outer end of each coil is fixed to a gear wheel, loose on the shaft, these wheels being driven continuously in opposite directions and carrying the coils around with them. Between the inner ends of the coils there is a sliding collar on the shaft which, when moved in either direction, comes in contact with the bell-crank lever, and tightens the last turn of the corresponding coil on the

drum. The motion of the gear wheel causes the coil to easily but firmly grasp the drum, and through the drum to drive the shaft. The action of reversal is not instantaneous with the coil clutch, hence it operates without shock. *Engineering* says that a copper rolling mill in France has been recently equipped with a train of rolls operated by an 800 horse power engine through one of the coil-clutch reversing gears made by the Consolidated Engineering Company, of Slough, England. The engine has a 46-ton flywheel running at 86 revolutions per minute, which gives great steadiness of operation to the rolls. The strength of the clutch is said to be so great that it is guaranteed to stand the tremendous strain of pulling up the engine to a dead stop should the rolls become jammed.

THE WEIGHT OF A CROWD OF PEOPLE.

Lewis J. Johnson recently read a paper before the Boston Society of Civil Engineers which was printed in the Journal of the Association of Engineering Societies, January, 1905, giving results of experiments recently carried out by him, which go to show that the data hitherto considered as standard on the subject of the weight of a crowd of people are in many cases far below the true figures. For instance, in Trautwine it is stated that people can hardly by any contingency on bridges, turnpikes, and common roads weigh more than 80 pounds per square foot. To compensate, however, for impact, Mr. Trautwine recommends the adoption of 100 pounds as the limit for crowds. The State building laws of this country specify 80 to 150 pounds for the minimum floor loads for public assembly rooms. Recent papers read before the American Society of Civil Engineers, however, have stated that 40 to 45 pounds per square foot is exceeded in practice so seldom as not to demand much consideration. In view of this statement, the experiments just undertaken by Mr. Johnson are especially interesting. He crowded men into a weighing box to such an extent that the maximum of 181.3 pounds per square foot was attained. This was the weight of forty men averaging 163.2 pounds apiece on 36 square feet, and was, of course, an unusual figure. However, if forty men weighing 163 pounds each can stand in no serious discomfort in 36 square feet, it is clear that forty men of the ordinary size of 150 pounds could easily do so. The result then would be 166.7 pounds per square foot.

The conclusion seems irresistible that loads of 180 pounds per square foot may actually occur in exceptional circumstances; that 160 must frequently occur; that 140 pounds must be common on station platforms, in corridors, and many other places frequented by throngs of people; and that 80 pounds per square foot must be common in social gatherings in private houses. The conclusion is equally clear that the margin of safety in many existing structures designed for 80 to 100 pounds per square foot, to say nothing of 40 to 45, must be much less than has been supposed.

NEW THEORIES CONCERNING RADIUM.

Theories recently put forward by Prof. Monroe Snyder, and Prof. Rutherford of McGill University, concerning the activities of radium, are of an exceedingly startling nature. Both gentlemen are, however, entitled to the utmost respect in everything that they have to say on the subject. Prof. Snyder, in a paper read before the American Philosophical Society, announced that he had discovered radium in the photosphere of the sun. In his opinion variable stars are caused not by the revolution of one body about another, but by the regular fluctuation of light due to periodical outburst of radial activity. He concludes that the sun is a variable star with a period of eleven years, and that the sun spots are one of the demonstrations of the emanations of radium. Other of the celestial phenomena, he thinks, are due to radium. Prof. Rutherford, while he does not leave the earth in his theories regarding radium, advances hypotheses no less startling. In an article in a recent number of *Harper's Magazine*, he speaks of the recent discovery that the radio-active bodies are able to emit an amount of heat about one million times greater than is evolved in the most violent chemical reaction. In the course of a year, one pound of radium would emit as much heat as could be obtained from the combustion of 100 pounds of the best coal, and at the end of that time the radium itself would be apparently unchanged and still giving out heat at the old rate. It can be calculated that this radium would on the average continue to emit heat at the above rate for about 1,000 years. The radium emanation stored in one gram of radium is about one cubic millimeter at atmospheric pressure and temperature. Assuming the molecular weight of this gas to be 100 times that of hydrogen, it can be calculated that one pound of the emanation, could it be collected, would initially radiate energy at the rate of about 8,000 H. P. The whole of the earth's crust undoubtedly is impregnated to some extent with radio-active matter. The amount of internal heat lost per second from the earth by conduction to its surface can readily be calculated. Since one gram of radium emits enough heat each hour to raise 100 grams of water through 1 degree C., the present loss of heat from the earth is equivalent to that which would be supplied by the presence of about 270,000,000 tons of radium. This amount, while large compared with the quantity of radium hitherto separated, is relatively small compared to the quantities mined of some other minerals, and if distributed uniformly throughout the earth's crust would correspond to only five parts in one hundred million per unit mass. Calculations made show that the radio-activity observed in soils corresponds to about this proportion of radium. If radio-active matter is distributed throughout the whole earth to the extent that experiment indicates, the heat evolved by the radio-active matter would compensate for the heat lost by the earth by conduction to its surface. According to this the present internal heat of the earth tends to be maintained by the constant evolution of heat by the radio-active matter contained in it.

STANDARD PRECISION SCREW.

In the daily consular report No. 2178, Mr. Walter C. Hamm, consul at Hull, England, refers to the need of a standard precision screw in the fine branches of engineering, and gives an interesting account of the method employed in the National Physical Laboratory at Bushy House, London, in the development of a standard screw. The British War Office four years ago appointed a committee of experts to investigate the subject and devise means for producing a screw of the utmost possible accuracy. The result of the labors of this committee is the new standard screw-cutting lathe which has recently been put in use, but of which no public test has yet been made.

"It became clear at an early stage of the investigation that to secure interchangeability in screws it was necessary to supply accurate standard leading screws from which the screws could be cut and to construct a special lathe on which these leading screws could be adjusted and measured. The standard screw now in Bushy House is made of compressed steel and is some 6 feet in length. The lathe to which it is attached exceeds 20 feet in length, and as it works to so fine a degree of accuracy as to correct an error of one ten-thousandth part of an inch, every precaution has been taken to protect it from the vagaries of temperature by housing it in a special building heated to a constant temperature of 60 degrees. The lathe differs in construction very greatly from ordinary lathes. The leading screw and the screw to be cut are coaxial. No gear wheels are employed, and there are means for automatically correcting even the most trifling errors of the leading screw.

"The lathe room, which is air-tight except for the ventilation afforded by inlets and outlets, is completely surrounded by an outer shell, and is provided with a glazed roof, while a glazed partition at one side enables observations to be made from the outside of the room. To prevent vibration, the lathe has been fixed on a foundation consisting of 20 tons of concrete covered with 6 inches of cork stone. The power is supplied by a 5 horse power motor, and arrangements are made for driving the lathe mandrel direct from the outside of the room. In this way the presence of anyone within the lathe room can be dispensed with for considerable periods at a time, and the machine with its automatic corrector can, under vigilant but unobtrusive supervision from without, be safely left to perform its allotted task with perfect fidelity and with such marvelous precision as almost to render the copy more perfect than the original.

For scientific purposes a screw must be so accurately cut and

its axis so true that it will move forward in its nut exactly the same distance for each rotation around its axis. It is said not to be difficult to produce a screw a foot or a yard long with errors not exceeding one one-thousandth part of an inch. Prof. William A. Rogers, of Harvard Observatory, invented a process by which a lathe tool while cutting a screw moved so correctly as to counteract the errors of the lathe. Machines have also been invented the errors of which, it is claimed, do not exceed one one-hundred-thousandth part of an inch at any one point. But the results have seldom been satisfactory. To secure the highest accuracy it has been necessary to resort to grinding."

METHOD OF SECURING INSERTED BLADES.

Zeitschrift fur Werkzengmaschinen und Werkzenge, October 5, 1904, p. 5.

There has been an effort for some time to substitute inserted tooth milling cutters for the solid and expensive head, and the variations in design have usually hinged upon the method of fastening the cutters. In Fig. 1 there is shown a cutter with spirally-arranged teeth, made of high-speed steel, with a

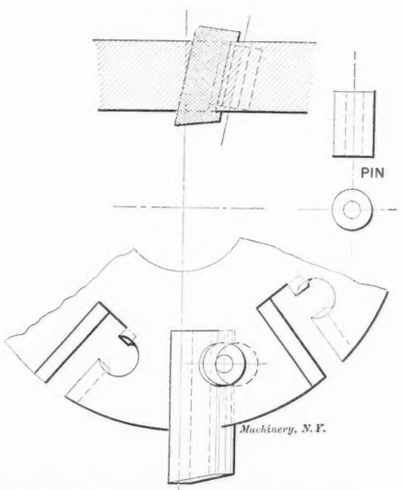


Fig. 1. Cutter with Spirally-arranged Inserted Teeth.

method of fastening that has proven reliable in service. A cylindrical pin somewhat larger in diameter than either of the circular openings is pushed into them by means of a simple contrivance. In order to increase the elasticity of the pin and with it the holding riction of the same, the latter is bored through from end to end. The steel is cut with a long groove that causes it to lip over on either side of the body of the holder. Even an imperceptible tightening or loosening is impossible in spite of the severest of shocks by which a screw fastening would be loosened. It is perfectly reliable and the parts are all interchangeable. When the steel is worn out it is removed from the head after pressing out the pin and another piece is put in in its stead. The cutters may have a diameter of 3 inches or more and a width of from ½ inch to ⅞ inch. The holder may be from ½ inch to ⅝ inch in thickness, or from ⅛ to ¼ inch thinner than the cutter

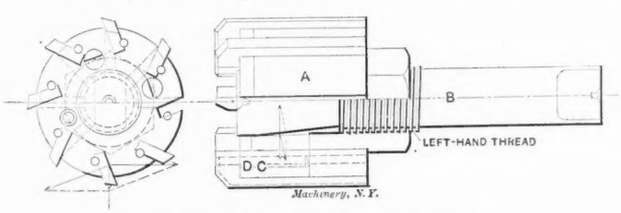


Fig. 2. Securing Inserted Blades in an End Mill.

which lips over it on each side. A number of these heads may be used side by side, by allowing the cutters to interlock into each other, thus setting one just behind the other. By this means the breadth of the cut can be regulated.

For use on flat surfaces with an end miller the form shown in Fig. 2 is used. By turning the head *A* to the right on the shank *B* until it is finally tightened, the pressure pieces *C* will be forced against the surfaces of the steel cutters and thus these will also be fastened. The construction of the pressure parallelogram, shows that the division of pressure is very well equalized. The bolt *B* is cut with a left-handed thread, and the cutters, when at work, have a tendency to turn the head *A* about the shank *B*, so that the pressure piece *C* is continually forced against the cutters; this circumstance, in connection with the close-fitting round pin, makes any slipping or loosening of the steel impossible. Such a tool can be handled and treated in exactly the same way as though it were made of a single piece, and if the cutters are sharpened after they are put in position, their cutting action will be the same as that of a solid tool. G. L. F.

CALCULATING CHARTS.

Abstract of article in The Mechanical World, Manchester, Eng., January 5, 1905.

The construction and use of charts in designing were fully set forth in the series of articles by J. S. Myers in MACHINERY for September to November. In this connection the charts given herewith may prove of value in expediting calculations on transmission. Fig. 1 is for the approximate determination of the width of belt to transmit a given horse power at any stipulated speed. The formula upon which the chart is based is:

$$W = \frac{33{,}000 \times \text{H. P.}}{\frac{T}{2} \times V}$$

Where W = width in inches.
T = working tension in belt.
V = velocity in feet per minute.

The three variable factors are H.P., $\frac{1}{T}$, and $\frac{1}{V}$. The above formula is based upon a coefficient of friction of .3 and an arc of contact of 135 degrees approximately, and takes no account

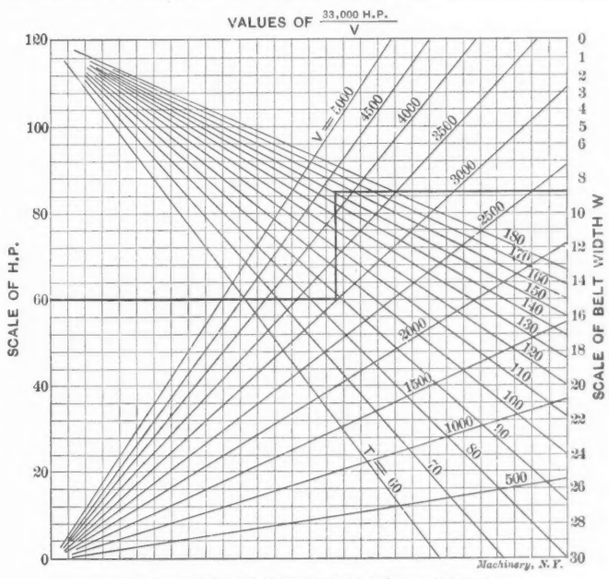


Fig. 1. Chart of Belt Widths and Horse Powers.

of centrifugal action, which considerably reduces the effective belt tension at high velocities. We are only concerned with the constants in fixing the limits of the chart.

In plotting this chart, maximum and minimum values are taken as given in the accompanying table:

	H. P.	T	V	$33{,}00 \times \text{H. P.} \div V$	$\frac{33{,}00 \times \text{H. P.} \times 2}{V, T}$
Maximum..	100	180	5000	6600	220
Minimum..	10	60	500	65	0.733

Horse power values are plotted to any suitable scale on the left of the diagram (in this figure carried to 120), values of the first product along the top line, and from the zero of the horse power scale sloping velocity lines to the correct points

on the upper line. On the right hand of the chart, downward, a scale of widths is plotted, reading to 30 inches. From the zero of the first product scale sloping lines are drawn downward to the correct points on the scale of widths, for the several belt tensions.

As an example of the use of this chart, let us find the width of belt necessary to transmit 60 horse power at a belt speed of 3,000 feet per minute, with an effective tension of belt of 150 pounds per inch of width. Enter the chart at 60 on the horse power scale, and move along the heavy line in the figure to the intersection of the 3,000 velocity line, thence vertically to the intersection of the 150 tension line, and on the scale of widths find the required width of 9 inches. Obviously the process may be reversed, and given width, speed, and stress per inch width, we may find the horse power transmitted.

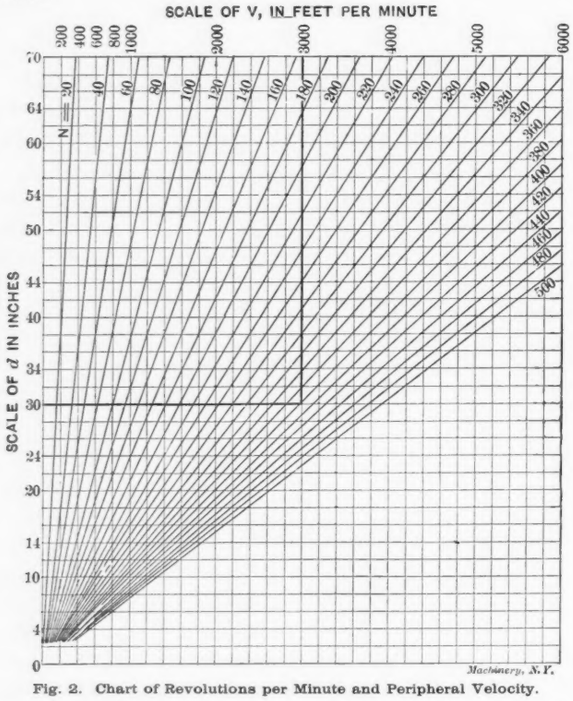


Fig. 2. Chart of Revolutions per Minute and Peripheral Velocity.

As the width varies directly as the horse power, it is obvious the chart is applicable to any values within a reasonable limit, as by multiplying or dividing any horse power on the chart by a multiple of ten, the corresponding width will be the width on the chart with the decimal point correspondingly shifted, and *vice versa*.

Fig. 2 is a chart expressing the relation between revolutions per minute, diameter of pulley in inches, and velocity of periphery in feet per minute, or $V = \frac{\pi d N}{12}$. where N represents revolutions. This chart is drawn to read a maximum of 6,000 feet per minute. Following the heavy line, we find that a pulley 30 inches in diameter, running at 380 revolutions per minute, has a peripheral speed of 3,000 feet per minute. This chart may well be used in connection with Fig. 1.

BENDING STRESSES IN WIRE ROPES.

From a Paper by Samuel Diescher read before the Engineers' Society of Western Pennsylvania, January 3, 1905.

According to the rule long since adopted in practice, sheave diameters shall equal or exceed forty-eight diameters of the corresponding ropes; that is to say, that for every ¼ inch of the diameter of the rope, 12 inches are to be allowed for the diameter of the sheave. That this ratio is adequate has been amply proved, and the advantages of using a sheave of this diameter over a smaller one are numerous. In what is to follow, this ratio will be assumed.

A formula for the calculation of bending stresses in wire rope is given in Kent. Tables containing the results of calculations for various sizes of ropes and sheaves are also given, but no cognizance is taken of the load hanging on such a rope in that formula, whereas, as a matter of fact, more effort is required to bend a rope if taut than if slack. This formula was apparently made under the impression that in bending a rope conditions are about the same as if bending a solid bar, but such is not the case. In the bending of a rope about a sheave a compensation between the strands may be shown to occur, by which the increase in the outer circumference over that of the neutral axis of the rope is supplied by a corresponding decrease in the inner circumference, without any part of the strand being severely stressed. This compensation occurs locally within every turn of the strand. The tendency to pull in the upper part of the bend is equal to that to shove in the lower part, and as both these forces lie in the same line and act in the same direction, they act in accord. Hence the movement within the strands would meet with no resistance but for the fact that the strands are in close contact with each other and the rope is in tension, due to the work it performs; hence a certain amount of friction must be overcome when the strands adjust themselves to altered conditions.

Considering a 2-inch rope and a sheave of 8 feet diameter, the outer circumference of the rope is approximately 1 foot greater than that of the sheave. The rope measured along its neutral axis is approximately one-half foot longer than the circumference of the sheave, hence the elongation that occurs on the convex side of the rope during one revolution is ½ foot, and the contraction on the concave side of the rope is also ½ foot, and this difference must be adjusted when the rope changes from a straight line to a circle by the excess of the concave side shifting to the convex side. This motion is the aggregate of all motions in one strand that occur during a full revolution, and must take place under the pressure the rope exerts against the rim of the sheave, which in turn reacts upon the rope and its strand. The resistance that opposes this motion is friction among the strands as they rub against each other.

The intensity of this friction depends upon the pressure applied, and the coefficient of friction of the materials in contact, which to be quite safe will be assumed to be 0.15. The pressure that the rope exerts upon the circumference of a cylinder of any diameter is $2 \times 3.14\ P$ per full coil, in which P represents tension in the rope due to its load. If we assume that tension, for example, at 30,000 pounds, one coil exerts upon the circumference of a sheave $2 \times 3.14 \times 30{,}000 = 188{,}400$ pounds. The circumference of an 8-foot sheave being 25 feet, the pressure upon one foot of this circumference is approximately 7,200 pounds. In a rope of 2 inches diameter a strand makes one winding turn around the core in 12 inches, in which length the compensation between compressed and pulled parts of that strand must also take place, and as this compensation is continuously occurring, and exactly 12 inches of that rope are always affected, it is evident that the resistance opposing that readjustment is the friction produced by the pressure upon 12 inches of that circumference of the sheave. Hence the friction thus produced is $7{,}200 \times 0.15 = 1{,}080$ pounds, and as there are six strands in the rope at all times engaged in the act of adjustment, the total bending stress in the rope will be $6 \times 1{,}080 = 6{,}480$ pounds.

The work done in this bending is the bending stress multiplied by the amount of motion in the strands during the process of adjustment in one revolution. As the whole movement of the strands within one coil of the rope on the sheave is ½ foot, the work of bending is $\frac{1}{2} \times 6{,}480 = 3{,}240$ foot-pounds.

Applied to a practical case, say a shaft of 1,000 feet depth, the same sheave will make $1000/25 = 40$ revolutions, and therefore the work done during one run in bending the rope is $40 \times 3{,}240 = 129{,}600$ foot-pounds. If this run is made in one minute the power consumed is 129,600/33,000 equals approximately 4 H. P., or if made in two minutes 2 H. P.

If, however, we want to use a sheave of only 4 feet diameter, the total pressure the rope would exert upon the rim of the sheave is independent of the diameter, but as the circumference of the sheave is only one-half as much as for the 8-foot sheave, the pressure per lineal foot of rope is twice as great and consequently the friction opposing the adjustment of the strands is double that in the case of the larger sheave. This is sufficient reason for the selection of large diameters for sheaves,

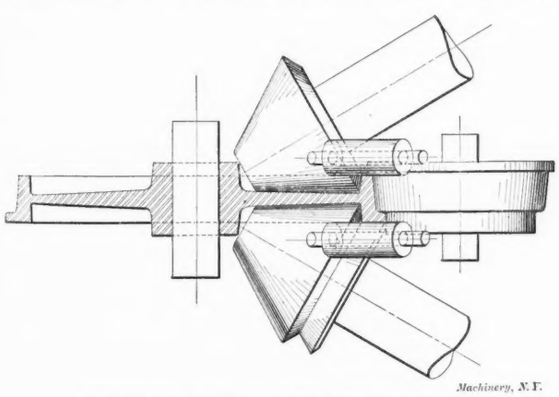
but also it must be considered that with a 4-foot sheave the compensating motion of a strand in a given length of rope is twice as great for the same length of rope as with the 8-foot sheave, so that the energy consumed in bending is four times that required with an 8-foot sheave. In short, the resistance opposing the adjustment of the strands grows inversely with the square of the diameter of the sheave, the velocity being the same in both cases. The straightening of the rope on leaving the sheave does not require any external force, because in the act of bending the elastic resistance of the sheaves must be overcome, whereby energy is stored in those strands, just as in compressing or stretching a spring which resumes its original state on being released. There is, of course, a limit to the compensating capacity of the strands in a rope, but this limit can only be determined by actual trials under working conditions. This task by right falls upon the manufacturers of wire rope.

ROLLED STEEL CAR WHEELS.

Abstract of Article by Samuel Vauclain, Superintendent Baldwin Locomotive Works, in the Journal of the Franklin Institute, February, 1905.

The requirements for car wheels have risen very rapidly during the last few years, the loads upon them having increased from fifty to a hundred per cent, whereas it has been impossible to increase the weight of the wheel in like proportion. The chilled cast iron wheels have been very successful in meeting the demands upon them, but the brittleness of the flange, inability to resist the heating effects of the brake shoe, internal stresses induced in the casting, etc., of this type have created a field for a wheel free from these objections. Steel tired wheels have been made, having centers of cast iron, cast steel and wrought iron and of both plate and spoke form. Even these wheels suffer from shelly spots on the tires unless great care and expense attend their manufacture.

A solid forged high-carbon rolled-steel wheel, to be successful, must be cheap enough to compete with the cast chilled wheels, and good enough to compete with the high-priced steel-tired wheels. The process of its manufacture is simple. An ingot is cut into sections, each of which is of sufficient weight to make a wheel, the upper or segregated section of the ingot being discarded. Each of these sections is then pressed into shape under a 5,000-ton hydraulic press, the blanks being handled by mechanical means. The blank is transferred from there by overhead cranes to the rolls, where it is subjected to enormous pressure, and revolved at a high rate of speed, emerging a perfect wheel. The method of rolling and the arrangement of the rolls is shown in the diagram. If the plate of these wheels is to be of the dished or curved form, the wheel is placed in the 5,000-ton press, and gently squeezed into shape.



Arrangement of Rolls for Rolling Steel Car Wheels.

The quality of the wheel is attested by examination of etched sections, and favorable judgment is confirmed by the results of the physical and chemical tests, the latter being very uniform, indicating the greatest uniformity in the wheel. Various severe impact and other physical tests have been successfully withstood by this type of wheel. One of the most severe tests that can be imposed upon the chilled iron wheels is the thermal test, which consists in pouring a ring of molten iron, 1½ inches thick and 4 inches deep, against the tread, no cracks to develop within two minutes. This test is to take account of the heat developed by the application of the brake shoe. A number of rolled wheels have been subjected to this test without injury to them.

As to the value of these wheels compared with cast chilled wheels of the best material and manufacture, the following statement has been prepared, comparing the cost of the two types per 10,000 miles:

SOLID ROLLED WHEELS.

Cost of pair of rolled wheels	$54.00
Cost of four turnings	2.40
Cost of four removals and applications	2.40
	$58.80
less scrap value	8.75
Net cost	50.05

Mileage, 350,000.
Cost per 10,000 wheel miles, $1.43.

CHILLED-IRON WHEELS.

First cost of pair of chilled-iron wheels	$18.00
Cost of boring and mounting	80
Cost of removal and application	60
	$19.40
less scrap value	5.80
Net cost	$13.60

Mileage, 80,000.
Cost per 10,000 wheel miles, $1.70.

The natural field for the rolled wheel is: (1) The severe service of engine and tender trucks, in which steel-tired wheels are now exclusively used; (2) passenger car equipment, in which the element of safety is very important; (3) heavy freight car equipment, for which the chilled iron wheel has proved inadequate. The wheels, however, are adaptable for lighter service, and could be profitably employed in street car service.

MULTIPLE-EFFECT EVAPORATION.

Abstract of a Paper read before the Manchester (Eng.) Association of Engineers, January, 1905.

The basic principle of multiple-effect evaporation, by which the effect of one pound of steam may be multiplied three or four fold in evaporating juices or liquids, may be illustrated by Fig. 1. Ordinary multiple-effect evaporators consist of two or more vertical cylindrical vessels, somewhat like surface con-

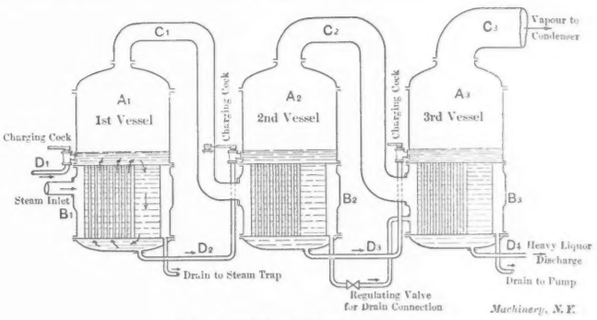


Fig. 1. Triple-effect Evaporator.

densers in character. Steam, either as the exhaust from the engines or direct from the boilers, is usually the source of heat by which the evaporation is brought about. The steam thus supplied is taken to the first of the vessels, where it surrounds tubes containing the liquor to be evaporated. The pressure inside the tubes is kept lower than the pressure of the steam supplied to the casing round the tubes, hence the boiling temperature of the liquor inside the tubes is lower than the temperature of the saturated steam outside, with the result that the steam will be condensed to water, which, however, will still be at a higher temperature than the liquor and vapor in the tubes. The heat thus given up will practically be the latent heat of the steam, and each pound of steam condensed will evaporate approximately one pound of the water in the tubes, thus generating steam in the tubes. This steam is then conveyed to the shell of the second vessel, which also contains tubes through which the liquor to be evaporated passes.

The pressures in the casing and tubes of the second vessel are lower than in the casing and tubes, respectively, of the first

vessel, hence the steam generated in the tubes of the first vessel now surrounds tubes containing liquor at a lower temperature than its own. It is therefore condensed, and in condensing evaporates approximately another pound of water. This system can be carried on to any number of effects allowed by the temperature limits.

In Fig. 1, a diagrammatic arrangement of a triple-effect evaporator, the steam enters the shell of the first vessel, as shown, and the liquor to be evaporated enters the tubes of the first vessel through pipe D_1, usually hot. The course of the operation is then as outlined above.

As the pressure in each succeeding vessel into which the liquor to be evaporated passes is lower than in the preceding one, no pump is required beyond that necessary to force it into the first vessel, a regulating cock, however, being placed between each vessel for the regulation of pressure, etc. The pressure in the last vessel is almost always below the atmosphere. In dealing with the concentration of certain liquors, it is desirable that the highest density should be accompanied by the highest temperature, as owing to the increased fluidity at higher temperatures, the concentration can then sometimes be carried to a greater degree. In this case the liquid, instead of entering the first vessel and finishing at the third, may have its passage through the machines reversed, in which case pumps are necessary to convey it from vessel to vessel owing to the pressure rising in the direction of the flow instead of falling.

In the design of such evaporators an important point is the rate of heat transmission from metallic surfaces. This is a

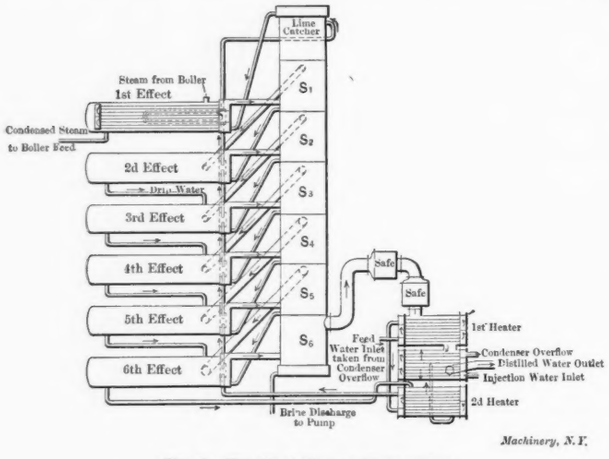


Fig. 2. Six-effect Yaryan Evaporator.

subject which, though much experimented upon, is still very vague. From results obtained, however, Newton's law that the transmission of heat is directly proportional to the difference in temperature, is no longer accepted as unconditionally true. It has been found that an increase in the rate of evaporation per square foot is caused by rapid circulation of the liquid in the tube, and doubtless this applies not only to evaporators and condensers, but also to boilers. The rate of transmission per degree of temperature difference is greatest when the temperature differences range from 15 degrees F. with a low speed of flow, to 40 degrees when the speed of flow is 5.4 feet per second. The rate of transmission also is three to four times as high when heat is transmitted to a boiling liquid than to one not boiling.

Fig. 2 represents diagrammatically a six-effect Yaryan evaporator. When used for the distillation of water the impure water is drawn from the circulating water which has passed through the condenser, and has thus become somewhat hot. It is then pumped through the first heater, then forward through the second heater, whence it passes through heater tubes shown dotted on the diagram.

By the time it has passed through the last set of heating tubes contained in the first or high temperature effect, its temperature will not be much below the temperature of the steam supplied to that effect. At this point it may be taken to a specially constructed lime catcher, shown on top of the separator column, where by the use of a steam coil and suitable reagents, most of the lime and similar salts are precipitated. Here, also, the water is filtered; it then passes to the evaporating tubes of the first effect. The shell of this vessel or effect receives steam from the boiler at a pressure of about 40 pounds per square inch. In many cases a higher pressure and a greater number of effects may be adopted where the liquor is such that treatment at a high temperature is not likely to be injurious, but machines are seldom made with more than six effects.

The water formed by the condensation of steam supplied to the first effect is usually returned direct to the boiler, which is thus fed with pure distilled water at a high temperature; consequently a high evaporation per pound of coal should result. The steam formed in the tubes of the first effect, together with the water, pass to the separator, S_1, where the steam separates from the water and is led to the shell of the second effect, while the water passes into the tubes of this effect. The pressure in the shell of this effect practically corresponds with the pressure in the tubes of the first effect, but the pressure in the tubes of the second effect is several pounds lower; hence, as the water entering the tubes is at the higher temperature of the previous effect, there is immediate and spontaneous evaporation of some of the water, which causes a lowering of the temperature of the remainder. This reduction of temperature permits of heat being transmitted through the tubes from the steam on the other side, causing evaporation of a further quantity of water, and the condensation of the steam outside of the tubes.

Again the mixed water and steam pass to the separator, S_2, and the separated steam is then led to the shell of the next effect, and the water to its tubes; but as the water produced by the condensation of the steam supplied to the shell of the second effect is not wanted for boiler feeding, it is drained into the shell of the third effect, as shown, and there imparts some of its heat to the water in the tubes. Spontaneous evaporation also takes place here, owing to the water entering a vessel in which the boiling temperature of water is lower than the temperature of the incoming water.

This cycle of operations is repeated in succeeding effects until the last one is reached, which in the example chosen is the sixth effect. From here the water drained from the second, third, fourth, and fifth effects, together with the water of condensation formed on its own tubes, is drained to the second heater, whence it passes to the condenser. The steam from the last separator, S_6, passes through the safes to the first heater, where some of it is condensed, the final condensation taking place in the surface condenser shown, where not only does this condensation take place, but the water so formed is, along with the water drawn from the previous shells, finally cooled by the circulating water in condenser.

It is evidently important that great care be taken in the design to see that no water is carried over with the steam, otherwise the purity of the distilled water produced would be vitiated. Results of tests made upon Yaryan six-effect machines have shown as high as 44 pounds of water evaporated and condensed per pound of fuel consumed.

THE STRENGTH OF COLUMNS.

Abstract of Paper by Professor W. E. Lilly, Trinity College, Dublin, before the Institution of Mechanical Engineers, February 17, 1905.

The formulas in general use for the design of a column of a given length to carry a given load do not take into consideration the ratio to be adopted between the area and radius of gyration of the cross section of the column which are involved in its design, it being left to the designer to assume empirically such values as seem most suitable. Theoretically there is for every column of given length and load a definite area and radius of gyration for the most economical cross section; for instance, in the case of a hollow mild steel column of circular cross section, the column fails by wrinkling of the sides of the column, or by secondary flexure, if the diameter is large and the thickness small; if the diameter is small and the thickness great, it fails by primary flexure or bending. The author of this paper made about eight hundred tests on hollow tubes, stressed as columns would be, with the view of determining the conditions under which failure occurs, and to obtain definite information as to the values of the areas and the radii of gyration of the best cross sections.

The tubes tested were of mild steel, and as nearly as possible of uniform quality. Tests were carried on in a 10-ton Wicksteed testing machine of the vertical type. The investigation was limited to round-ended columns, owing to the small size of the machine.

The results of the tests were averaged and curves plotted showing the relation between the breaking load and the length divided by the radius of gyration. From these curves the curves here given, as Figs. 1 and 2, were prepared. In Fig. 1 the influence of the thickness in determining the load which produces failure is shown, the curves A to F being deduced from the curves just referred to, the diameter and thickness of the tube being varied and the area of the cross section kept constant, the uppermost curve of the series being for the limiting case when the tube becomes a solid bar. The curves shown in Fig. 2 were obtained by plotting the curves of Fig. 1 to a base line representing length, and ordinates representing breaking load. From these curves it will be seen that the economical ratio of the diameter and thickness for a given cross section depends upon the length of the column. The breaking strength of tension of these tests averaged nearly 72,000 pounds per square inch, and the average of the breaking strength for compression was 80,000 pounds per square inch, which was used throughout in plotting the curves given. Experiments also made determine the coefficient of elasticity as having an average value of thirty million pounds per square inch, which value was used in plotting the curves.

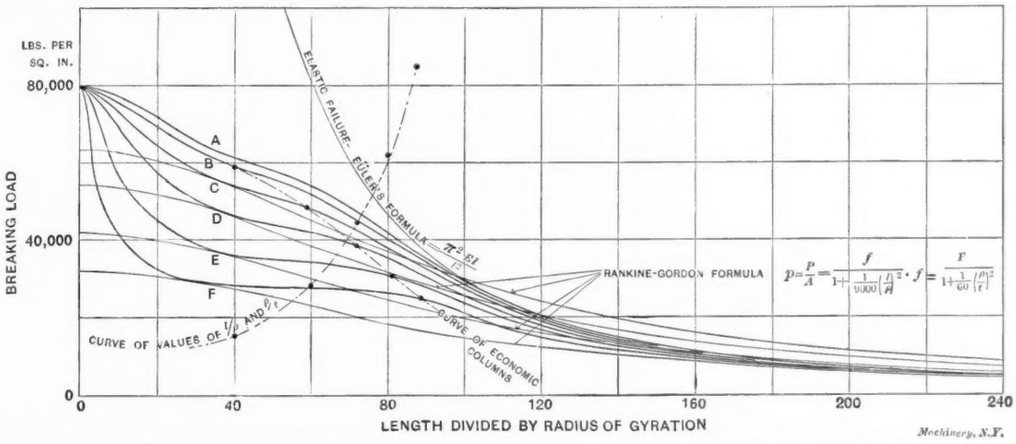


Fig. 1. The Relations between the Breaking Load and the Length Divided by Radius of Gyration of Columns.

The following phenomena were observed throughout the tests: that for all columns there was a certain value of l/ρ in which l is the length and ρ the radius of gyration, beyond which the failure was sensibly due to elastic bending, the load producing failure varying inversely as the square of the length, and that as the value of ρ/t, where t represents the thickness of the tube, increased, the value of l/ρ increased for the load producing failure by elastic bending. It was also remarked that when failure of the column took place by secondary flexure for a large range of the length, there was little variation in the breaking load, and also that as the load approached the breaking load, there was on the short lengths a distinct yielding of the tubes before failure.

The formulas in most general use for the design of columns are Euler's and the Rankine-Gordon formula. Euler's formula is $P = \pi^2 \dfrac{E\,I}{l^2}$, where P equals the load on the column, E the coefficient of elasticity, I the moment of inertia of the cross section, and l the length of the column. This formula is only applicable to columns which fail by elastic bending, that is, long columns. For practical columns with the usual ratio of l/ρ, it fails to give the breaking load. It applies quite accurately to long columns, the influence of the ratio ρ/t causing but little variation in the strength.

The Rankine-Gordon formula is $P = \dfrac{f\,A}{1 + c\left(\dfrac{l}{\rho}\right)^2}$, where

f = about two-thirds the compressive strength of the material, for wrought iron = 36,000 pounds; A = area of the cross section, $c = \frac{1}{9000}$ for columns with round ends, $= \frac{1}{36000}$ for columns with fixed ends; l = length of column, ρ = radius of gyration of the cross section.

This formula gives approximately the breaking load for both short and long columns, the value of f and c being determined by experiments. It does, however, take no account of the ratio ρ/t, nor does it point out the most economical values of l/ρ to be used.

In the diagram Fig. 1, the breaking load for the tubes calculated from Euler's formula is shown. For values of l/ρ greater than 120 for the solid bar to values of l/ρ greater than 240 for the thinnest tubing, the failure is sensibly elastic, and the experiment is in accord with the values as calculated. ,

The curves shown in Fig. 1, drawn to refer to tubes of constant cross section, were deduced from the curves of individual tests in the following manner; the Rankine-Gordon formula was used in the form:

$$p = \frac{P}{A} = \frac{f}{1 + \dfrac{1}{9000}\left(\dfrac{l}{\rho}\right)^2}$$

suitable values being given to f.

It was found that the strength depended in some way on the ratio ρ/t, since the breaking load was less when the diameter was varied and the thickness constant, and greater when the thickness varied and the mean diameter was constant. By plotting values, the following formula was obtained:

$$f = \frac{F}{1 + k\left(\dfrac{\rho}{t}\right)^2}$$

where F = the compressive strength of the material, and k = a constant for mild steel = 1/60.

For the solid bar the value of f is sensibly equal to F. This formula closely gives the required values and appears to be of the correct form. Substituting for f in the Rankine-Gordon formula, the latter now takes the form:

$$p = \frac{P}{A} = \frac{F}{\left[1 + k\left(\dfrac{\rho}{t}\right)^2\right]\left[1 + c\left(\dfrac{l}{\rho}\right)^2\right]}$$

putting $k = \frac{1}{60}$ and $c = \frac{1}{9000}$ for columns with round ends,

$$p = \frac{P}{A} = \frac{F}{\left[1 + \frac{1}{60}\left(\dfrac{\rho}{t}\right)^2\right]\left[1 + \frac{1}{9000}\left(\dfrac{l}{\rho}\right)^2\right]}$$

This formula was used to determine the curves shown in Fig. 1, the value of F used being 72,000 pounds per square inch. The remaining curves showing the actual failure of the columns were plotted from the curves averaging individual tests, before alluded to, and refer to tubes of a constant cross section of 0.12 square inches, of the sizes given in Table 1.

TABLE I. DIMENSIONS OF TUBES OF CONSTANT CROSS SECTION.

External Diameter. Inch.	Internal Diameter. Inch.	t	ρ	Reference to Curves.
1	0.92	0.04	0.34	F
0.875	0.78	0.048	0.3	E
0.75	0.636	0.057	0.25	D
0.625	0.481	0.072	0.2	C
0.5	0.3	0.1	0.15	B
0.4	0	0.2	0.1	A

The diagram Fig. 1 thus obtained may be used for mild steel columns with round ends having the same ratios l/ρ and ρ/t.

The formula takes into consideration both the primary and secondary flexure of the column. The latter will be of maximum strength when the strength for primary flexure is equal to that of secondary flexure. The diagrams show the variation of ρ/t, with the length for a constant cross section. This ratio will now be put in a simple form so as to be of practical use.

In Fig. 1 the economical values of l/ρ were plotted from the curves in Fig. 2, giving the dotted curve as shown; this may be considered as approximately a parabola having the equation:

$$\left(\frac{l}{\rho}\right)^2 = 1000\left(\frac{\rho}{t} - 0.5\right)$$

For practical values of l/ρ the term 0.5 can be omitted, giving the simplified form $\rho^3 = 1\text{-}1000\ l^2 t$. (1.) This equation applies to the column of hollow circular cross section; for columns of other cross section the constant 1-1000 requires to be slightly modified.

about sixty to ninety for the ordinary run of columns, and solving equation (3) the value obtained is

$$A = 2 \text{ to } 3\,\frac{P}{F}$$

where P is the load on the column and F the ultimate compressive strength; this must be divided by the factor of safety for the practical column, giving

$$A = 2 \text{ to } 3\left(\frac{PS}{F}\right)$$

where S = the factor of safety.

Substituting for A in equation (2) the economic values of ρ can be easily determined. Checking up the dimensions of the column thus ascertained by the general formula, we find that the safe load, P, will in general be greater for actual practice than is given in the formula, an error on the side of safety.

There has been considerable diversity of opinion as to the value of the constants that should be used in the Rankine-Gordon formula, owing to the incompleteness of the experimental work hitherto carried out. For the ordinary ratios of ρ/t in practice, the Rankine-Gordon formula gives fair results, but it does not apply with the same accuracy to solid bars or columns in which the ratio of ρ/t is large; it is quite far from the truth for values of l/ρ at which failure takes place by elastic bending. As Euler's formula is sensibly true for long struts the author proposes a modification of the latter for this case, which, however, involves the use of several constants, for which further experimental data are needed before its adoption.

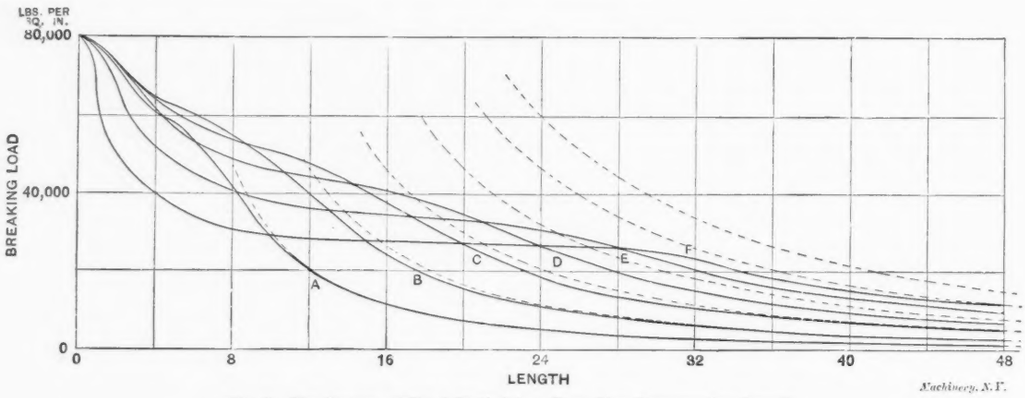


Fig. 2. The Curves of Fig. 1 Plotted to a Base Line Representing Length.

If A is the area of the cross section and d the mean diameter of the column, $\pi d t = A$ approximately. Also $\rho = \frac{d}{\sqrt{8}}$; hence $t = \frac{A}{8.9\,\rho}$ approximately. Substituting in the previous equation—

$$\rho^2 = \frac{\sqrt{A}}{94}\,l$$

for hollow circular columns and for other cross sections

$$\rho^2 = \frac{\sqrt{A}\,l}{h} \qquad (2)$$

h being a constant depending on the value ρ/t of the cross section required.

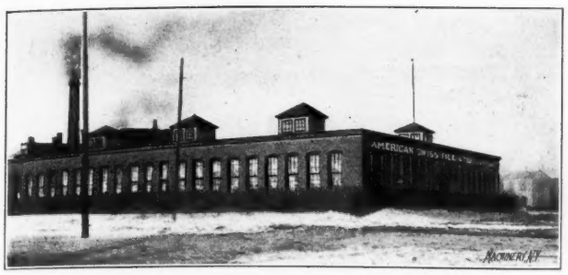
This equation shows that ρ varies as $\sqrt{l}$ if the area of the cross section is constant. Now A represents the area of the cross section, and is supposed to be known; to determine it, values of p and l/ρ for the economic section were plotted, giving the curve as shown in Fig. 1, the equation of which is approximately—

$$p = \frac{P}{A} = \frac{F}{1 + \frac{1}{3500}\left(\frac{l}{\rho}\right)^2} \qquad (3)$$

The equation resulting from substituting F or A from equation (2) is difficult of solution; hence proceeding tentatively, and assuming a probable value of l/ρ for the column, usually

HARD-DRAWN COPPER WIRE.

In a paper—"Telephone Line Engineering"—read by Mr. C. J. H. Woodbury before the January 12th meeting of the Franklin Institute, allusion was made to the important improvement made in copper wire for aerial lines by Thomas B. Doolittle. Although it was early recognized that copper wire was much better suited to the needs of telephony than iron wire, its use was impracticable because of the soft, ductile nature and low tensile strength of commercial wire. When suspended between poles it would continue to stretch until it became so attenuated that it would break of its own weight, or touch the ground and thus interrupt the circuit. Doolittle's great improvement consisted essentially in omitting the annealing processes during the latter part of the drawing, and attenuating the wire by smaller gradations of the die-plates. In this manner the copper wire was made with a dense hard surface, causing it to receive the appellation of "hard-drawn." The increase of strength is naturally greater in the smaller diameters since the treatment affects the thin surface layers most. For instance, a hard-drawn No. 8 copper wire is 0.165 inch diameter and has a tensile strength of 62,100 pounds per square inch of cross-section, while No. 12 wire, 0.104 inch diameter, has a tensile strength of 64,600 pounds. It will be seen that the strength is nearly doubled since commercial copper wire has a tensile strength of only about 32,000 pounds. The modulus of elasticity is increased from 12,000,000 to 19,000,000 pounds and the elongation before rupture is reduced from 35 per cent to 1¼ per cent. This remarkable change is effected entirely by manipulation and without the addition of any alloy.



THE MAKING OF FINE TOOLMAKERS' FILES BY AMERICAN METHODS.

An interesting industry has been established at Elizabethport, N. J., which is an example of the application of American methods to the manufacture of products that have heretofore been mainly produced in the Old World by slower hand processes. This industry is that of the American Swiss File & Tool Co., which began operations in its present factory in 1900. Its founder is Mr. Edward P. Reichhelm, mechanical engineer, and president of the American Gas Furnace Co., New York City.

The manufacture of the larger, heavier and coarser grades of files commonly used by machinists has always been an important industry in America, and their production of these has been so successful that they have not only supplied the de-

Fig. 2. A Corner of the Forge Shop.

mand of the home market but have competed successfully in Europe with those made by foreign companies. The finer grades, however, used by toolmakers, diesinkers, jewelers, watchmakers, and others, have always been imported from Switzerland in large quantities. The file-making industry in Switzerland has developed as a necessary adjunct of the watch industry in that country, and the Swiss files in the finer grades have reached a high degree of perfection. In the manufacture of Swiss watches the parts have been and are still largely shaped by hand and as the file is the tool most used in this work it is natural that attention should have been given to the production of small files to meet the home demand. This condition is responsible for the success of the files made in Switzerland.

Mr. Reichhelm, who has given his personal attention to the development of the industry at Elizabethport, has long been of the opinion, as the result of his experience in the use of gas furnaces for hardening and annealing steel, that it would be possible to produce the best results in file manufacture by methods somewhat in advance—from a commercial standpoint—of those employed in Switzerland. The American Gas Furnace Co. manufacture oil-gas machines and furnaces of many descriptions, and in the installation and operation of the many plants which they have designed a fund of information has been acquired in regard to the treatment of steel that is well-nigh invaluable in the manufacture of a product like files, in which absolute uniformity of results is desirable.

The American Swiss File & Tool Co. occupies a small but new and well-equipped factory, and there is land for such extensions of the plant as may be required. As the process of file-making is not understood by many it will be of interest to follow through the different steps and refer to features of the process which have made this company successful in their venture. While the steps of manufacture taken by themselves appear to be extremely simple and are no different from what may be found in other lines of work, the development of the process as a whole has not been by any means an easy matter. In fact so many technical difficulties were encountered that at the end of a year and a half the investment actually required footed up to four times the amount included in the first "liberal estimate" made. While the original conception of the methods of production proved to be correct it required much patient labor to put them into practice with a working force which had to be newly created.

A view of the new plant is given herewith. It is a one-story brick structure, lighted both by side and roof windows. In developing the process of file manufacture attention was first

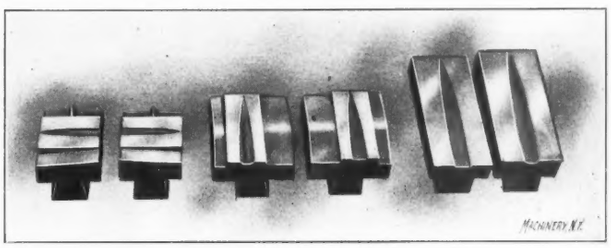


Fig. 3. Three Sets of Dies for Forging the Blanks.

given to the heat treatment of the steel. It is necessary, first, that the stock should be annealed in a way that will not injure the steel and that will produce steel of uniform hardness, not only in each individual file, but in all the files of the successive lots which are in progress through the works. By securing, first of all, this uniform quality in the file blanks it is possible to cut the teeth in a satisfactory manner and if equal attention is given to the shaping of the blanks and to the hardening, straightening and cleaning of the finished product the most essential points will have been provided for.

The main innovation in the manufacture of these files is the use of the gas apparatus previously referred to, by which the same accurate results are obtained in the quality of file blanks as are secured in plants manufacturing milling cutters and other tools requiring careful annealing and hardening. In this system a gas-generating plant is employed by which gas is produced from naphtha. Naphtha is utilized as being the best adapted to this purpose of any of the petroleum products. It is a refined product freed from all substances that cannot be atomized by moderate force or vaporized under a temperature below 80 degrees F. It may be completely converted into gas with no residue, and by suitable apparatus it is possible to

Fig. 4. Blanks in a Gas Furnace ready for Annealing.

secure a permanent gas of high calorific power which will have no tendency to condense in the apparatus where it is employed. Another advantage of naphtha over crude petroleum products is that it is freed of all trace of sulphur or other elements that can in any way injure the quality of the steel. In annealing with naphtha gas it is not necessary to pack the articles to be treated in a cast-iron box since the direct heat of the furnace, if kept at the proper temperature, can in no way harm the steel.

The process of producing naphtha gas is carried on in an

apparatus in which the main element is a large metal tank or generator made up in three sections. In the bottom section is the naphtha, which is forced into the middle section where it mixes, in the form of a spray, with a stream of heated air. The air and naphtha then pass to the third section where they are forced through several screens, causing a minute subdivision of the naphtha spray and a close intermingling of the air and naphtha. The naphtha is so finely subdivided that it produces a permanent gas, and if at this point any particles are not sufficiently subdivided to mingle with the air they drop to the bottom of the chamber, where they are drawn off and return to the tank. At one point in the process the air is allowed to drop sufficiently in temperature to cause a condensation of whatever water-vapor it may contain. This assists in the commingling of the air and naphtha-vapor. The gas is finally heated by passing through coils subjected to steam heat before it is used, and it is employed in the furnace in Machlet burners, where it burns in contact with an air blast supplied by a positive-pressure blower.

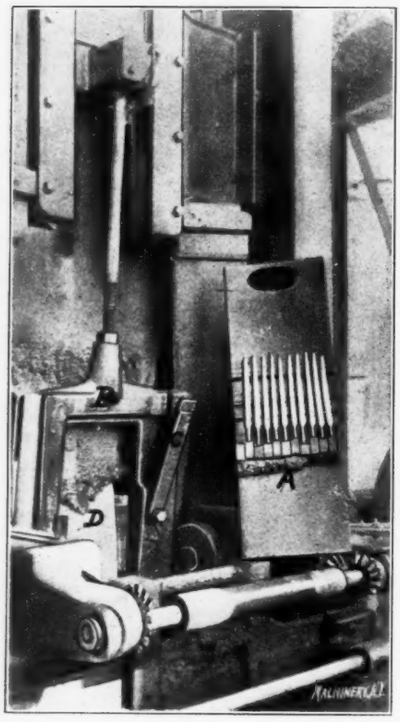


Fig. 5. Machine for Grinding Blanks.

The forging of the blanks is done mainly under Bradley hammers, one of which, with the gas forge, is shown in Fig. 2. The method of working with these hammers is familiar to most of the readers of MACHINERY. The facility with which the blanks can be shaped depends upon the dies employed, three pairs of which are shown in Fig. 3. The face of each die is made in three sections, as shown in the two left-hand pairs of dies in Fig. 3. The section on one side of the die is used in breaking down the edge of the stock, that on the other side for bringing the edge of the stock to approximately the right dimensions, and the central portion is employed in forming the flat sides or faces of the blanks. The pair of dies

Fig. 6. Cutting by Hand.

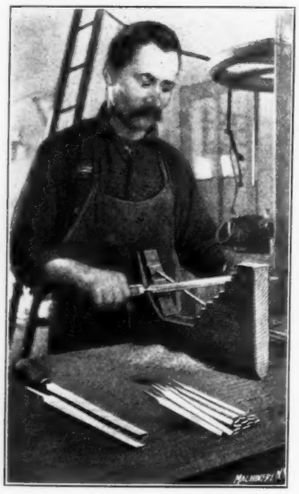


Fig. 7. "Stripping" File Blanks.

Two Instances of Hand Methods.

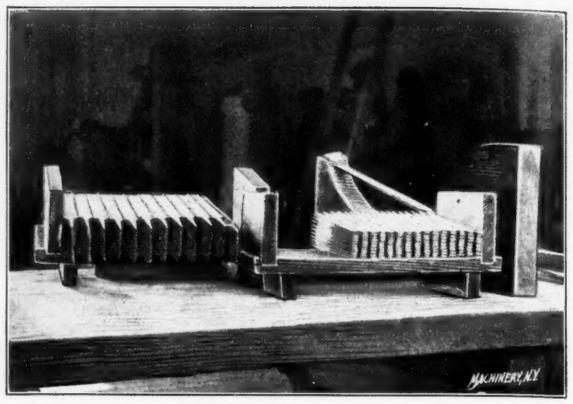


Fig. 8. Stacks of Blanks ready for Cutting—Note Uniformity of Height of Different Piles.

at the left is for forging the blanks for warding files; the pair at the center for half-round files, and the pair at the right is used in a drop-hammer only, for the purpose of finishing the blanks of half-round files. Special shapes, like half-round files, Barrette files, etc., are finished by drop forging, while the ordinary shapes are finished under Bradley hammers.

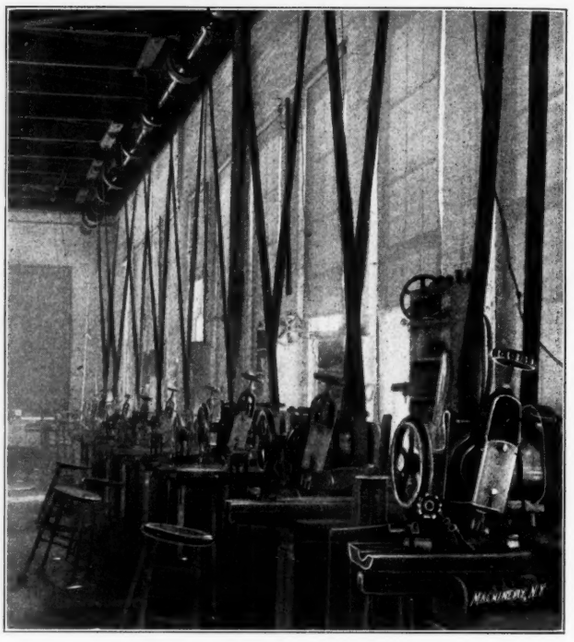


Fig. 9. A Row of File-cutting Machines.

The second step in the process is annealing. Fig. 4 shows the interior of a furnace with a stack of files ready for annealing. They are placed in two piles, with the tangs extending outward, so that the delicate tips of the files, which in tool work have to do much of the cutting, will not be injured by too intimate contact with the reflected heat from the hot walls of the furnace. The files are heated some four or five hours, according to the sizes of the blanks, and then are allowed to cool for twelve or fifteen hours before the furnace is opened for their removal.

After annealing, the blanks must be straightened, which is accomplished by heating momentarily over a gas flame and at the same time subjecting the file to a slight pressure at the point needed to bring it into shape.

The next step is grinding the blanks ready for cutting. Special machines are used for much of the grinding, a portion of one of which is shown in Fig. 5. The grindstone, *D*, does the grinding. The files are clamped to a flat plate, *A*, which fits in a holder, *B*, and is locked in position by the piece *C*. This holder reciprocates in a vertical direction and moves the faces of the files up and down against the surface of the rotating grindstone, the stone at the same time having a longitudinal motion crosswise of the files. Other grinding is done by hand, on grindstones, and in some cases on emery wheels,

the round files, for example, being finished in this way by means of a special machine in which the blank is held in a chuck having both a reciprocating and a rotary motion. The method of grinding depends to a considerable extent upon the shape and size of the file. After the cutting portion of the file is ground the tangs are then finished.

Before going to the cutting machines the blanks are finished by draw-filing or by "stripping," as it is called in this work. This is one of the instances where hand work enters into the making of the file. While the shape is determined mainly by the forging and grinding operation, it is necessary that the finishing touches should be put on by hand to insure that nicety in the forming of the blank that the expert workman so much desires. Draw-filing also produces a finish superior to grinding.

In Fig. 8 are stacks of files finished ready for cutting. There are some 15 or 16 files in each pile in the left-hand stack and so uniform is the thickness of the files that the top surfaces of the 12 piles that make up the stack form practically one continuous smooth surface.

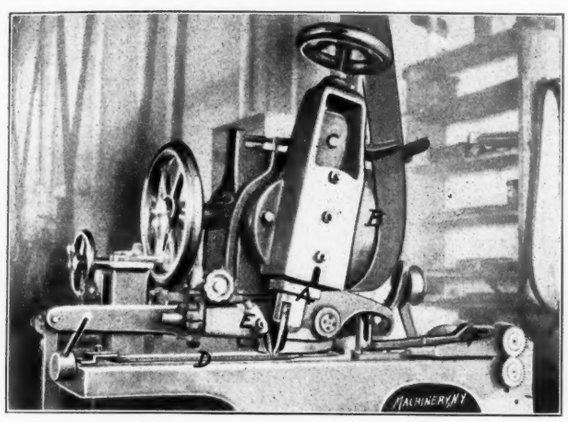


Fig. 10. Larger View of File-cutting Machine.

In Fig. 9 is a row of file-cutting machines, where the seventh operation is performed; while in Fig. 10 is a larger view of one of the machines. Contrary to what is probably the belief of many users of files, it is contended by these manufacturers, and they believe to have demonstrated, that there is no inherent merit in hand-cut files or even in irregular spacing for machine-cut files. For the most part, the files are cut with the teeth uniformly spaced, though in the case of files of certain types running to a point, provision is made for decreasing the pitch as the point is approached. The main requisites for a properly cut file are first of all, a blank of uniform hardness throughout, so that the teeth may have a uniform degree of sharpness; a properly shaped cutter, set at the correct angle, and a machine adjusted to give a blow of sufficient intensity to produce a sharp tooth at the pitch at which the file is being cut.

The file-cutting machines are manufactured by the Hess Machine Co., Philadelphia, and are a type quite generally used in the file industry both here and abroad. In Fig. 10, *D* is a file clamped in position for cutting, and is steadied at the point where the tool acts by the holder *E*. The slide carrying the file receives its motion by an extension which is drawn through the friction rollers, *F*; the cutter spindle, *A*, is driven by means of a ratchet cam through the pulley *B*. The cam raises the cutter spindle and compresses a rubber collar, *C*, which, when the high portion of the cam is passed, strikes the blow. The degree of compression of the rubber collar is regulated by the handwheel at the top, which thus determines the force of the blow. Files are cut very rapidly, the blows being delivered at the rate of 2,000 or 3,000 per minute, and when one side is finished the blank is turned over and the other side is cut. The blanks rest on a strip of sheet lead, to avoid injuring the teeth during the operation. Certain machines are fitted with a compound feed arrangement, by which the spacing of the teeth is changed, giving an "increment cut" as the point of the file is reached.

Files with fine cuts have their teeth formed by another method called etching. The process is a hand one, and produces results akin to knurling in the engine lathe. The cutting tool is a long triangular bar, on the three edges of which are milled or knurled minute teeth similar in depth and shape to the teeth of the files to be cut. The file blank is clamped in position or, in the case of round files, is rotated gradually, and the cutting tool is passed over the blank in a manner similar to the movement of a file when draw-filing. The process is one requiring considerable skill. In the hands of a skilful workman the knurling tool can be given exactly the right angle and the right pressure, securing teeth of absolute regularity.

The class of work done by toolmakers is such as to require many files of special shapes, and in consequence a considerable portion of the product of this company is made to order, to conform to the wishes of its customers. This necessitates hand cutting in some cases, and in any event the work of the machine is supplemented by hand cutting, wherever it is required to give the desired degree of nicety. In Fig. 7 is a view of a hand cutter at work. It is a noticeable fact that nearly every trade has its own type and shape of hammer, and file cutting is no exception to the rule.

After cutting, the number and maker's name is stamped on the file and it then goes to the hardening room where the file is finished. It is here heated in a gas furnace and cooled in brine. Before the file is completely cooled it is straightened, and is then ready to be cleaned by the sand blast, in which latter process a fine clay powder is employed such as will not injure the teeth of the file. After inspection the product is ready to be oiled and packed in the shape in which it is delivered to the customer.

* * *

V-BLOCKS FOR PLANING KEYWAYS IN SHAFTS—JIG BLOCKS.

Fig. 1 shows a convenient V-block clamp made by Edward G. Herbert, Ltd., Manchester, England, for holding shafts on the planer platen while cutting keyways, etc. With this device no loose plates or packings are required, and the holding-down bolts are not disturbed when changing shafts. Every shaft is clamped exactly alike, the screw forcing the shaft into the vees bringing every one into exact parallelism, provided, of course, the V-blocks are accurately set at the start. It is obvious that this device can also be profitably used on the drill-press for holding shafts and other cylindrical work for drilling.

The box jig shown in Fig. 2 is another device brought out by this concern for drilling machine parts, it being possible

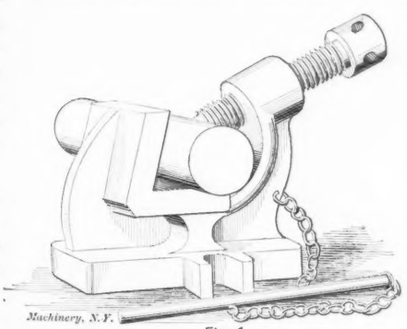


Fig. 1

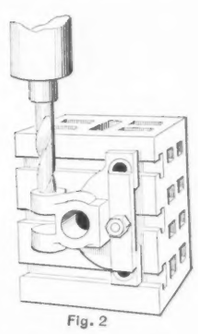


Fig. 2

by its use to drill or machine at one clamping of the work any surface parallel to the sides of the jig, which is accurately machined and squared on all sides. It can be readily understood that a set of such box jigs used in conjunction with a drill-press having a bracket attachment for guide bushings can be profitably employed on many classes of work for accurately drilling pieces for which it would not be profitable to make a regular drill jig. It should be possible to secure a fair degree of interchangeability by providing locating pins on the face of the box jig, and parallel strips clamped to the drill-press table which would fix the different positions of the jig and work for drilling. In fact it seems to us that this principle is one susceptible of many profitable applications in almost every shop.

ADVICE TO APPRENTICES.

JOHN MARK MAY.

The first thing to decide is what trade you are going to learn, for it is at the very start that a great many mistakes are made. It so often happens that a boy's main object is something that will pay him well, a trade that will hold him for a short apprenticeship only, or clean work that will admit of his wearing fine clothes. Again, perhaps the father or some influential relative (with good intentions) picks out the trade that he thinks he would like the boy to learn, regardless of the taste and ambitions of the boy himself; but if you get the opportunity, by all means learn the trade you have a natural taste for, remembering that there is a demand for first-class workmen in all trades, however crowded the middle and lower ranks may be. The chances of success are so much greater when the mind is kept upon the work being done, that it is well worth careful thought to select something that you have evinced a talent and liking for. Having made your selection, be thoughtful and conscientious, and do what you feel to be just and honorable to your employer and your fellow workmen rather than adopt rules and customs followed by careless, indifferent men.

Don't drink. I don't mean by this, don't get drunk, but don't drink intoxicating liquors at all. The premium on temperate men has never been higher than at the present time. You may be told that there are lots of good, intelligent men who drink and are holding good positions, and this we will have to admit, but at the same time I say that every one of those men would be better and of more value to their employers if they did not drink at all. Manufacturers and railroad companies are spending thousands of dollars annually on evening schools and in donations to the Young Men's Christian Association for educating their younger help and keeping them away from drinking resorts, and the employers find it profitable to do so. Be honest and truthful! When you are so unfortunate as to break or in any way damage a tool or make a mistake in your work, admit the fault frankly. Your foreman will soon find that he has one man whom he can trust and will gladly excuse any error he can, for, knowing that an honest, trustworthy workman feels worse about a faulty or spoiled job than any one else, and finding so many who hide and deny every mistake that there is the least chance of escaping blame for, he will enjoy rewarding those who deal squarely with him. Be polite at all times! Some of your associates in the shop may be rough, profane, and abusive, but if you continue to be polite and maniy you will have an influence on them that is bound to be felt and will result in mutual benefit.

Strive to make your employer's business a profitable one, for if it is not profitable he surely cannot do well by you. Don't compare yourself with anyone else thinking that you are doing as much and as well as they, but just compare your work with the best you can do, remembering that as your efforts make your employer's business more profitable so they also make you a better workman and a more valuable employee. Be on hand promptly in the morning and walk out of the shop at the end of the day's work at the same gait that you came in. I know this is the exception rather than the rule, but I have never yet known an employer who, in looking for his best help, would pick out the men who dash out of the door first after quitting time at night. You cannot all meet with great success, but you can all do your duty and take advantage of the opportunities offered, and this is all that the very greatest have ever done.

A few hints as to the use of tools may not come amiss. The apprentice of the present day usually gets a better schooling on machine work than on hand work; therefore take advantage of every chance to learn points and get practice in filing and chipping. A much smaller proportion of this work is now done than formerly; nevertheless the man who can do it well has an advantage for general work. This is a micrometer age, but the old caliper is still a very necessary tool, and a few lessons from some of the older men who learned its value before micrometers were in general use will not come amiss. Old Chris, it seems, was brought up on calipers. He has no use for micrometers—they didn't have them in his younger days, and it is hard *sometimes* to teach old dogs new tricks, etc., and calipers are good enough for him. There is no mistake about it, he can do some excellent sizing with the aid of a caliper; not but that he could do better with a micrometer if he were not too stubborn to use one. He can, however, handle a pair of calipers to perfection and any apprentice who is favored with points on calipering from Old Chris is making a great mistake if he does not take advantage of them, for the caliper can generally be used to advantage together with the micrometer.

* * *

"CENTER-PRESSURE" STOP VALVE.

A new type of steam stop-valve is being introduced by J. Hopkinson & Co., Huddersfield, England, which embodies an interesting construction designed to overcome some of the faults of the ordinary type of disk valve. In the disk valve, especially when of large size, the springing of the valve body due to unbalanced internal pressure, has a tendency to distort the diaphragm and valve seat, and cause leaks. Another fault is the tendency to cut and score the seat when opening and closing the valve, owing to the high velocity of steam when passing through a constricted opening. Figs. 1 and 2 show the Hopkinson valve closed and open, and it will be noted that two opposing valve disks are employed instead of one. These disks work in opposite directions, of course, each being worked positively and independently by its own valve spindle, but only one handwheel is required. When

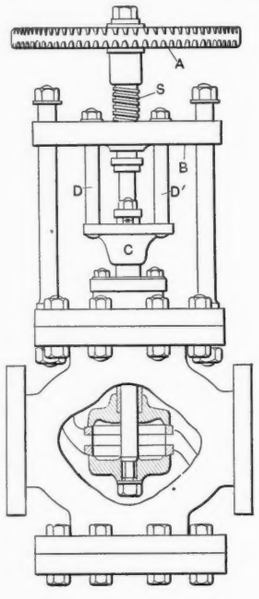


Fig. 1.

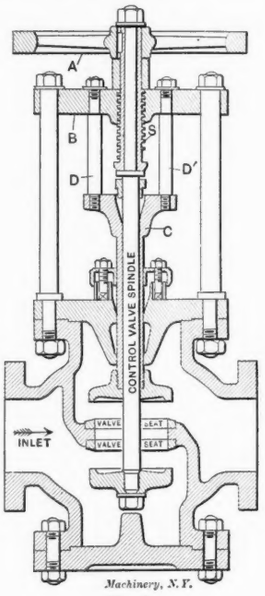


Fig. 2.

the valve is closed the steam pressure holds the lower disk firmly to its seat, and in opening, the upper disk raises first. The rotation of the handwheel causes the hollow screw, *S*, to which it is keyed, to raise the floating bridge, *B*. This in turn raises the upper disk by means of its connection to the stem, *C*, through the studs, *D D'*. Further rotation of the handwheel after the bridge has reached the upper limit of its travel, forces the center spindle and lower disk downward against the steam pressure and actually opens the valve so that steam can flow through. Closing the valve is the reverse operation, the lower disk seating first and the upper disk last. It will be noted that closing the valve requires less effort on the part of the operator, as the steam pressure assists in closing the lower disk, and the upper one is closed against no resistance whatever so far as steam pressure is concerned. When the upper disk is forced tightly against its seat the screw pressure tends to balance the steam pressure on the lower disk and to prevent distortion of the diaphragm. The upper lid joint is relieved of all pressure when the valve is closed, and the stuffing-boxes may be packed under steam pressure when the valve is closed. The lower lid, or cover, permits the lower disk to be examined and repaired without dismantling the entire valve. The valve was developed for high-pressure and superheated steam.

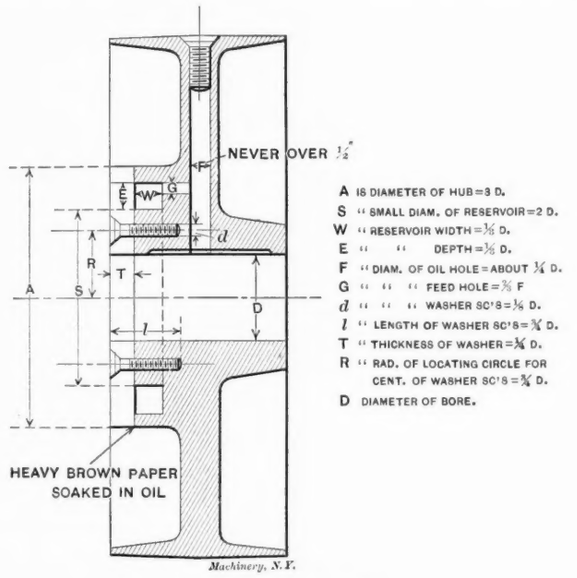
LETTERS UPON PRACTICAL SUBJECTS.

SULPHUR AS A PACKING BETWEEN BED PLATES AND FOUNDATIONS.

Editor MACHINERY:

Running melted sulphur under the bedplate of a steam engine, pump, or any other piece of machinery, as a permanent packing between the bedplate and foundation is not by any means new, sulphur having been used for that purpose, for years; but as it has proved in my experience to be the very best material for the purpose of making a perfect packing, the sulphur expanding in cooling so as to fill perfectly the space between the under side of the bed and the masonry of the foundation, I heartily recommend it for that purpose. The method of performing the work is so simple that it can be accomplished by a neophyte if he will follow strictly the following directions:

Level up the bedplate on iron wedges, placing them at such intervals as will not permit the casting to sag, leaving the space between bedplate and foundation from one-eighth to three-sixteenth inch high. Pack with well-worked clay close all around the casting, leaving risers or sprue holes at such intervals and of sufficient height to insure the space being


NEVER OVER ½"
HEAVY BROWN PAPER SOAKED IN OIL
A IS DIAMETER OF HUB = 3 D.
S " SMALL DIAM. OF RESERVOIR = 2 D.
W " RESERVOIR WIDTH = ⅛ D.
E " " DEPTH = ⅛ D.
F " DIAM. OF OIL HOLE = ABOUT ¼ D.
G " " " FEED HOLE = ⅜ F
d " " " WASHER SC'S = ⅛ D.
l " LENGTH OF WASHER SC'S = ⅜ D.
T " THICKNESS OF WASHER = ¼ D.
R " RAD. OF LOCATING CIRCLE FOR CENT. OF WASHER SC'S = ¾ D.
D DIAMETER OF BORE.
Machinery, N.Y.

Loose Pulley for High Speed.

entirely filled. Turn the nuts of the fastening bolts home to the casting all round. Melt the sulphur over a very slow fire, taking care that the sulphur is simply hot enough to become fluid. It will run like water. When it is just past the melting point pour into as many sprue holes as will allow the sulphur to run under the bed and, uniting in one mass, rise and fill all the risers or sprue holes. If run up full while in a fluid state the sulphur will expand in cooling, and all the fastening bolts will be found tight. Remove the clay, chip off the sprues and you have a smooth, neat joint, which will last indefinitely, if the waste oil from the engine or other machinery is not permitted to accumulate around the foundation; for oil will dissolve sulphur. If for any reason the foundation cannot be kept free from waste oil, clean the joint and cover it with a coat of paint. If the bedplate is an open one, cover the joint on the inside with a layer of putty, following with a coat of paint. C. E. MINK.

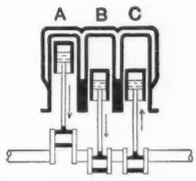
Syracuse, N. Y.

LOOSE PULLEY DESIGN FOR HIGH SPEED.

Editor MACHINERY:

Some time ago the writer was associated with an engineer in changing over a power plant, and among the problems which came up was the placing of a dynamo which required the use of a loose pulley that must run 1,750 revolutions per minute for about six hours per day. The cut shows the one designed and used, together with formulas for proportions.

The pulley may be designed to ordinary proportions, such as are given in MACHINERY data sheet of November, 1904, except the part of hub containing the oil reservoir, and for this purpose the proportions given in the cut are satisfactory. If, in the use of these, the dimensions do not give standard sizes for the screws in washer and oil hole, they may be changed



THE STROKE EVENTS OF A 3 CYLINDER GAS ENGINE											
REVOLUTIONS	1ST HALF		2ND HALF		3RD HALF		4TH HALF				
CYLINDER A	EXPLODE		EXHAUST		CHARGE		COMPRESS				
" B	CHG.	COMPRESS		EXPLODE		EXHAUST		CHARGE			
" C	EXHAUST		CHARGE		COMPRESS		EXPLODE		EXH.		

Machinery, N.Y.

Successive Events in Three-cylinder Gas Engine Cylinders.

slightly to the nearest standard obtainable; it is never necessary to have the oil hole over ½ inch diameter. Between the pulley and washer face is a heavy brown paper gasket soaked in oil before being put in place.

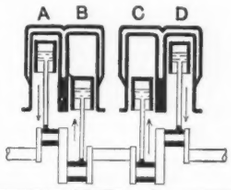
This pulley has been running about a year and a half, and it has never given trouble from heating. Its simplicity makes it easy to handle in the shop, and in this case it has given perfect satisfaction. JAMES A. PRATT.

Howard, R. I.

TABLES SHOWING THE SUCCESSIVE EVENTS IN THREE- AND FOUR-CYLINDER GAS ENGINES.

Editor MACHINERY:

I send you two tables, which I have made and found very handy in gas-engine work, thinking they may be of use to some of your readers. One table is for a three-cylinder engine and the other is for four cylinders, and both explain themselves so well that little need be added.



THE STROKE EVENTS OF A 4 CYLINDER GAS ENGINE				
REVOLUTIONS	1ST HALF	2ND HALF	3RD HALF	4TH HALF
CYLINDER A	CHARGE	COMPRESS	EXPLODE	EXHAUST
" B	EXHAUST	CHARGE	COMPRESS	EXPLODE
" C	COMPRESS	EXPLODE	EXHAUST	CHARGE
" D	EXPLODE	EXHAUST	CHARGE	COMPRESS

Machinery, N.Y.

Successive Events in Four-cylinder Gas Engine Cylinders.

If one wishes to know what is taking place in the cylinders of his engine at any given part of a revolution, he can tell at a glance by simply reading down one of the vertical columns in the table. The four-cylinder table shows there is an explosion for every half revolution of the engine shaft. The three-cylinder table shows an explosion in every half revolution, but there is an interval of one-sixth revolution additional between explosions, when there is none. For convenience the tables represent exhaust as commencing at the beginning of a stroke, whereas in practice it begins a little before.

Chelsea, Mass. R. L. WILLIAMS.

LATHE GEARING COMPENSATION FOR CHANGES OF LEAD DUE TO HARDENING.

Editor MACHINERY:

As nothing has been said of late in your columns regarding the shrinkage of steel in hardening, especially its effect upon the pitch of screws, I herewith submit a formula which will be found very useful to all having to contend with troubles of this kind. The formula, as given, is intended to aid in finding the ratio of change gears to be used when cutting a thread which is a certain amount longer or shorter in one foot than the same thread would be if regularly pitched. Of course this amount varies according to different makes and grades of steel, and no rule can be given for determining same; experience alone must be relied upon in that matter. Even when working with the most uniform grade of steel, and handling it with the utmost care, there is no sure telling whether the result will be shrinkage or expansion. However, if it has been found that a certain kind of steel has an invariable tendency to go one way or the other, it may be fairly well assumed that the same steel will vary in the same way in most cases, though the amount of shrinkage or expansion may vary somewhat from time to time. I have even observed exceptional cases where different parts of the same piece have shown considerable difference in the amount of shrinkage or expansion.

To overcome the troubles that would arise in fitting a correctly threaded piece into a hole tapped with a tap, the lead of which had become incorrect in hardening, it has become a practice to cut the tap with a lead such an amount longer or shorter than the regular one as has been found to be the average amount that taps made of the same steel will shrink or expand. The gearing of the lathe for such thread-cutting has always been regarded as more or less confusing, but the following formula will aid in finding proper ratio of change gears to use in such cases:

a = amount thread is longer or shorter in one foot than the same number of threads would be, regularly pitched.

n = nominal number of threads per inch on work to be threaded.

l = threads per inch on leadscrew of lathe.

r = ratio of gears in head of lathe.

R = ratio of change gears to cut a thread a certain amount, a, longer or shorter in one foot than same number of threads regularly pitched.

Then

$$R = \frac{l \times r\,(12 \pm a)}{12\,n}$$

using plus for threads cut longer and minus for threads cut shorter in a foot than regular. The ratio of change gears having been thus obtained, the proper gears to use can readily be found by trial, suiting the gears on hand.

As before mentioned, nothing positive can be said about the amount of change likely to occur when hardening steel, but to give a general idea to those who are not familiar with its peculiarities in this respect I would add the following data concerning two kinds of steel much used by prominent manufacturers.

Atha steel has an average shrinkage of from 0.016 inch to 0.020 inch per foot, the larger value being the nearest correct amount for small diameters of work, that is, up to ⅝ inch. For larger diameters a proportionately smaller value of shrinkage between the limits given above can usually be assumed.

Jessop's steel changes about the least and is the most uniform of any kind of steel that I have heard of or had experience with. The average shrinkage of this steel is so small that it gives it a great range of usefulness in cases where other steels make trouble. The amount of change is only from about 0.004 inch to 0.006 inch per foot, these values being in proportion to smaller or larger diameters of work, as remarked above.

Of course many conditions will have to be taken into consideration to obtain satisfactory results. The amount of change not only depends upon the grade of steel, but upon the uniformity and amount of heat used when hardening, the rapidity and manner of cooling, and also upon the number of times the work has been through the fire. Data as given above are for steel annealed only once. In regard to the effect upon steel of repeated annealing, a few interesting remarks might be made. If after having been through the fire once the pitch of a tap is correct, and it is annealed and hardened again, each consecutive repetition of this process will invariably bring about a growing error. Again, if a certain kind of steel should be too long in the lead after the first hardening, a second, or if necessary, a third hardening is likely to bring about a satisfactory result in so far as concerns the pitch, though this is not advisable, as tool steel generally loses its good qualities by having been through the fire too many times.

HANS DAHLSTRAND.

Milwaukee, Wis.

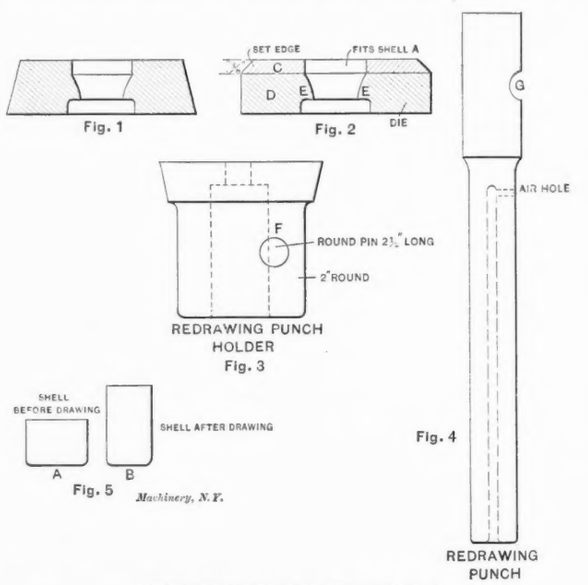
MAKING REDRAWING DIES ECONOMICALLY.

Editor MACHINERY:

Apropos of the bolster described by me in the January issue of MACHINERY I would like to add the following which may be of interest to your readers:

The description of the bolster in the January issue shows how it is used in connection with cutting and drawing dies. The same style of bolster is also used for redrawing dies when redrawing brass shells, thereby saving time and steel.

In the past it has been our custom to make our redrawing dies solid, as shown in Fig. 1, and fasten them in a bolster having four setscrews which are screwed up against the outside taper part of the die. Our present method, however, is to make the redrawing die in two parts as shown in Fig.



Making Redrawing Dies Economically.

2, of which the "set-edge" C is made to fit the shell A before it is redrawn. D is the redrawing die that draws up the shell B from the shell A.

These "set-edges" are made in various sizes, and are used in connection with different sizes of drawing dies. It sometimes happens that one "set-edge" is used with as many as ten different drawing dies. It is a well-known fact that when a redrawing die is worn out, it is shrunk, or in other words rehardened and is ground and lapped back to size. In making the die solid as shown in Fig. 1 the hole for the "set-edge" also requires grinding after the die is shrunk. It can, therefore, be very readily seen that time and steel are saved by making the redrawing die in two parts as shown in Fig. 2.

Perhaps a word or two would not be amiss at this time in regard to holding the drawing punch in the ram of the press. We have done away with the setscrew and check-nut method, and have adopted the following method with better results, of which very little explanation outside of the cuts shown at Figs. 3 and 4 is needed.

The gray cast-iron punch holder fits the dovetail channel in the ram of the press and is held in position by a key (not shown). The round pin shown at F engages in the half-round

groove *G* in the drawing punch, when the punch is placed in the punch holder, thereby preventing the punch from pulling out when the shell is being stripped from the punch by the sharp stripping edge shown at *E*. While the drawing punch as shown may appear to be made somewhat longer than is necessary for drawing up the shell *B*, it is made long so that the punch can also be used in drawing up various lengths of shells of the same inside diameter. C. F. EMERSON.

IMPROVISED DRAWING TABLE.

Editor MACHINERY:

The ingenious drafting board described in the February issue for those who have to do their drafting "on the wing" as it were, suggested to me that some correspondence school student or any mechanic who does drafting at home might possibly derive some benefit from the simple drafting table I find so convenient.

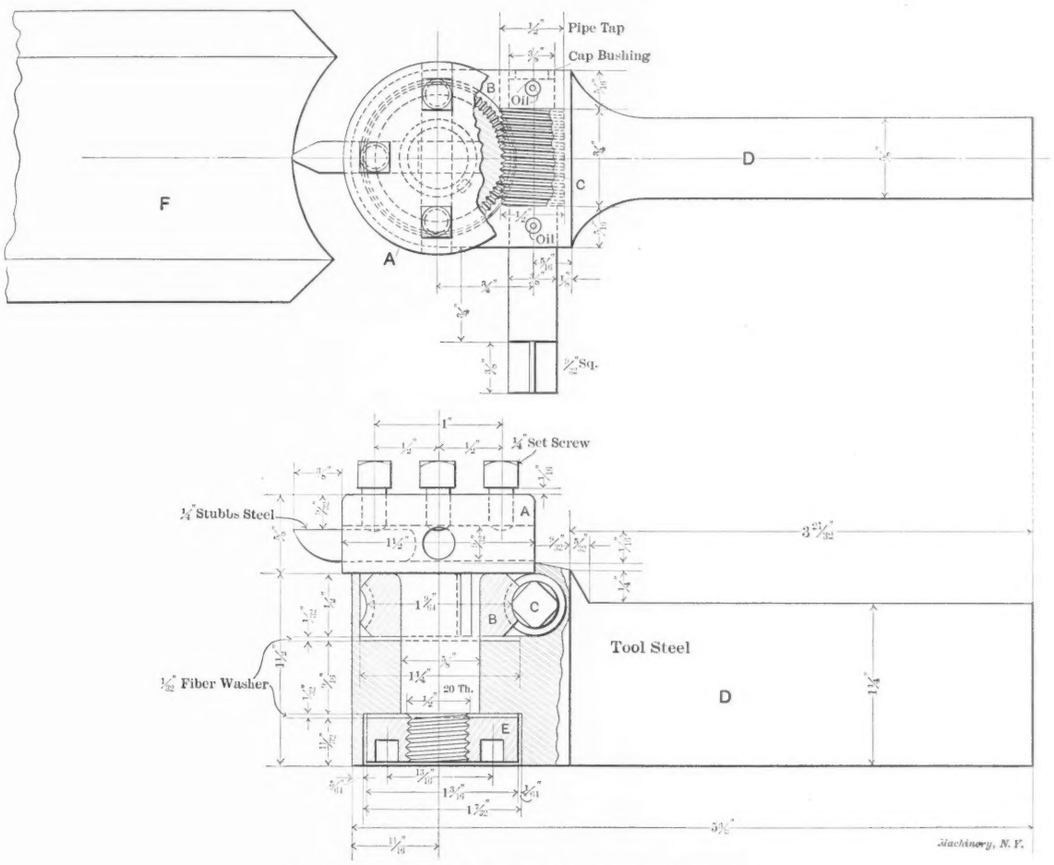
A pair of one-inch iron butts on the cleats of an ordinary drawing-board fasten it to any table that is available; one with a drawer is preferred. Let the board be hung over the drawer and have the hinge on the table come under the edge. After the board is hung satisfactorily remove the rivets in the butts and substitute split pins for the same. The drawing board is then easily removed from the table when not in use by withdrawing the split pins so that the butts separate, the half remaining on the table not being objectionable. By pulling the drawer out different distances and letting the board rest upon it any degree of inclination desired is easily obtained. GEO. WASHINGTON.

RADIUS LATHE TOOL.

Editor MACHINERY:

At one time I worked on a lathe and had a number of worm gear blanks to turn very frequently. I got tired of roughing them out with a tool and finishing the arc with a scraper to a templet made for each sized gear, so I designed and made a radius lathe tool as shown in Figs. 1 and 2. I found it to be very useful, as it eliminated the use of a scraper and templet, and quickened the job very materially. As shown in the drawing, the tool has a turret head *A*, with holes for four tools which are held by setscrews. By having four tools in the turret each one can be set for a different radius if desired, which saves changing tools when different sized gears are cut. The turret is fitted with a wormwheel *B*, in which engages the worm *C*. The original design of the tool provided for 1-32 inch fiber washers between the worm and the shoulder of the holder *D*, and between the nut *E* and the holder. These, however, were omitted as the slow motion of the tool made their use unnecessary. In using the tool, I would first take an ordinary brass roughing tool, and rough the arc of the wormwheel, *F*, out by my eye, and then set the radius tool to the proper position and length, whereupon a handle on the square of worm *C* was used to slowly revolve the tool to finish the wormwheel to the exact arc required. F. H. WHIPPLE.

Schenectady, N. Y.



Figs. 1 and 2 Radius Lathe Tool for Wormwheel Blanks, etc.

COMPRESSED AIR AS AN AID TO FAN BLAST IN FORGE SHOP.

Editor MACHINERY:

During an extra rush of work in the blacksmith shop, caused by engine failures and snow blockade, something extra in the way of noise was heard in the fan corner. The engine was stopped and an examination showed that every blade of the fan was broken off close to the hub. A new fan on short notice was out of the question, but the difficulty was quicker overcome by calling in the pipe gang and piping the forges for compressed air. The fan conduits were laid in the ground and connected to the forges with 2-inch pipe. These pipes were disconnected and taken to the drill-press and holes for ¼-inch pipe drilled in them. The ends of some short pieces of ¼-inch pipe were plugged and 1-16-inch holes were drilled through the plugs. One of these short pieces was thus inserted in each 2-inch pipe and connected to the air mains with a ¼-inch valve convenient to the blacksmith's hand. By leaving the slide valve in the fan pipe open, the velocity of the jet of air draws quite a volume of air through the fan conduit, giving a good soft blast.

After fan was repaired the air system was left intact, and the

following are a few of the good points of this system. If the fan belts break or run off, or if the engine slows down, because of an extra heavy load, thus making the fan blast insufficient, or if the engine is stopped for any cause for a few minutes, the blacksmiths have only to open the air valves and go on with their heats. It is also convenient for round-house work, nights and Sundays, as the air supply is independent of the engine and the shafting need not be run for short jobs.

Malone, N. Y. A. E. MITCHELL.

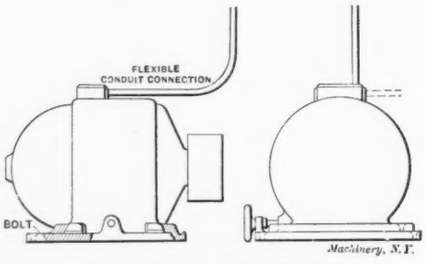
SMALL MOTORS AND DYNAMOS.

Elmer E. Warner.

Editor MACHINERY:

In the manufacture of dynamos and motors the multipolar ring type of generally high efficiency is much used, and I would like to suggest specifications for certain features of construction for this type of motor which, if adopted, would assist in creating a standard type, much to the benefit of users of such apparatus. Let us briefly outline some requirements of the general service for the smaller sizes.

First, it must be simple, efficient, durable, automatic and compact. It must be self-contained; that is, requiring neither extra oil pan nor boxing. It must be adaptable to various locations and modes of drive. Second, it must have the degree of insulation resistance prescribed by the National Code for installations of its capacity, so that it may be directly-connected to conduit systems or machines of any description without the use of extra or extraneous insulation for shaft or bedplate. Third, all current-carrying or "live" parts must be under the general surface. Armature leads and field connections should be carried up *inside* the frame to large and rigid binding posts on a thick insulating block on top of the machine, protected by an iron case or projecting ribbing. These posts should be plainly stamped to facilitate proper connection and provided with lugs where the current flow exceeds 33 amperes. The nameplate should be on the cover of this case or face of ribbing, and the words "Keep Clean" should be cast in large rounded letters just below. Solid or gauze paneled covers should be provided according to conditions of service.



Proposed Motor Outline Design.

Fourth, it should have the greatest possible symmetry, smoothness and simplicity of contour. All corners should be well rounded and projecting bolt heads, nuts, etc., avoided. It should be well filled, heavily enameled, and painted a neutral and unobtrusive color. This subserves cleanliness, reduces the liability to injury from accidental contact, and is true art and good taste.

The outer end of the bearing at the commutator end of the machine should be capped over flush with the casing. The sliding base used for the belt drive should be a ribbed plate with a low rounded lip around the outer edge to catch any oil that may be spilled in filling oil wells. The feet of the frame should dovetail into this plate, as indicated in the sketch, and one adjusting screw be provided, operated by cheap ratchet with short pipe handle, or a handwheel. Bosses should be provided at corners for holding down screws, as indicated.

For direct connection this machine would be furnished, of course, minus the sliding base and with feet drilled and planed only on the bottom.

E. E. WARNER.

Brooklyn, N. Y.

ELMER E. WARNER, born at Newton, N. J., 1871, attended high school and later took an evening course at Pratt Institute, Brooklyn. He served his apprenticeship with the E. W. Bliss Co., and has since worked for the Excelsior Electric Co., the C. & C. Electric Co., the New York Navy Yard, and the Electrical Bureau of New York City. He was machine shop foreman, then superintendent of electric construction and installation, and he now pays special attention to shop organization for electric construction work.

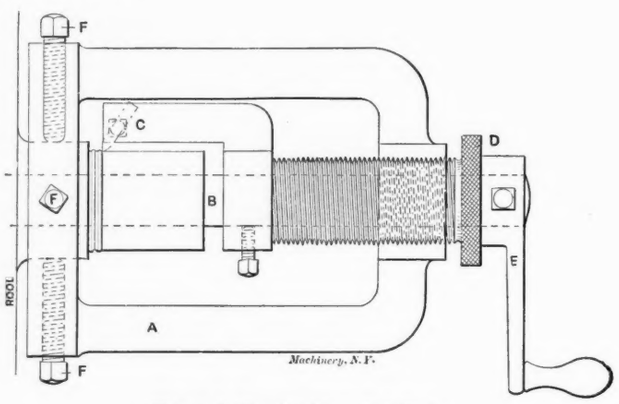
DEVICE FOR TURNING STEAM ROLL NECKS.

Editor MACHINERY:

Having in mind a job I was once called upon to do in a dyeing plant, and believing it might be of interest to some of the readers of MACHINERY, I will endeavor to describe it.

The job mentioned was repairing a mangle, which was used in drying the warp; it consisted chiefly of a series of large rolls which were about two feet in diameter, and twenty feet long. They were built of sheet copper, and brass heads with hollow shanks, being constructed this way to hold steam which assisted in the drying process. The shanks were run in stuffing-box bearings which, of course, in time caused them to become worn to such an extent as to quickly eat the packing, and make a leakage of steam and water.

There being no machine shop within a radius of several miles with facilities for turning the roll shanks, and being unable to find any one who cared to assume the responsibility of moving them without injury, it dwindled down to the necessity of a fixture by which we could turn them in the room; this was successfully matured in a comparatively short space of time.



Fixture for Turning Steam Roll Necks.

The device was in the form of a hand fixture as shown in the sketch. The holes in the shanks having been reamed 1¼ inches diameter while in course of construction, all that was necessary to make them all one standard size was a hand reamer to clean out the dirt and corrosion. This furnished one point to work from, as it was found the holes lined perfectly, and the bar *B* was made 1¼ inches diameter to fit the holes. In placing the fixture *A* ready for operation the knurled screw *D*, which is the device for feeding, was screwed back until the end was flush with the inside of the frame. The bar was inserted in the hole in the shank, it being long enough to have a full bearing in the hole at all times. When the tool was within about 1-16 inch of the end of the shank, the four setscrews *F* were tightened upon the neck of the shank (which was not to be turned off) and were so adjusted as to allow the bar to turn freely. When the device was in operation the several parts which come in contact with the feedscrew created nearly sufficient friction to cause it to feed itself.

This device proved to be a great time-saver and complete success in every detail; on several occasions I have set it up and turned a shank in half an hour.

New Haven, Conn. OTIS D. STORER.

COMBINATION FORMING DIE.

Editor MACHINERY:

The cut shows a combination forming die, for shaping the piece shown at the right. It is of composite construction, and was designed with a view to produce the article as cheaply as possible. The lower half of the die includes the pieces *I*, *J*, *K* and *G*, which are of tool steel, while the piece *S* is machinery steel, and *X* is cast iron. *O*, which is a piece of angle iron,

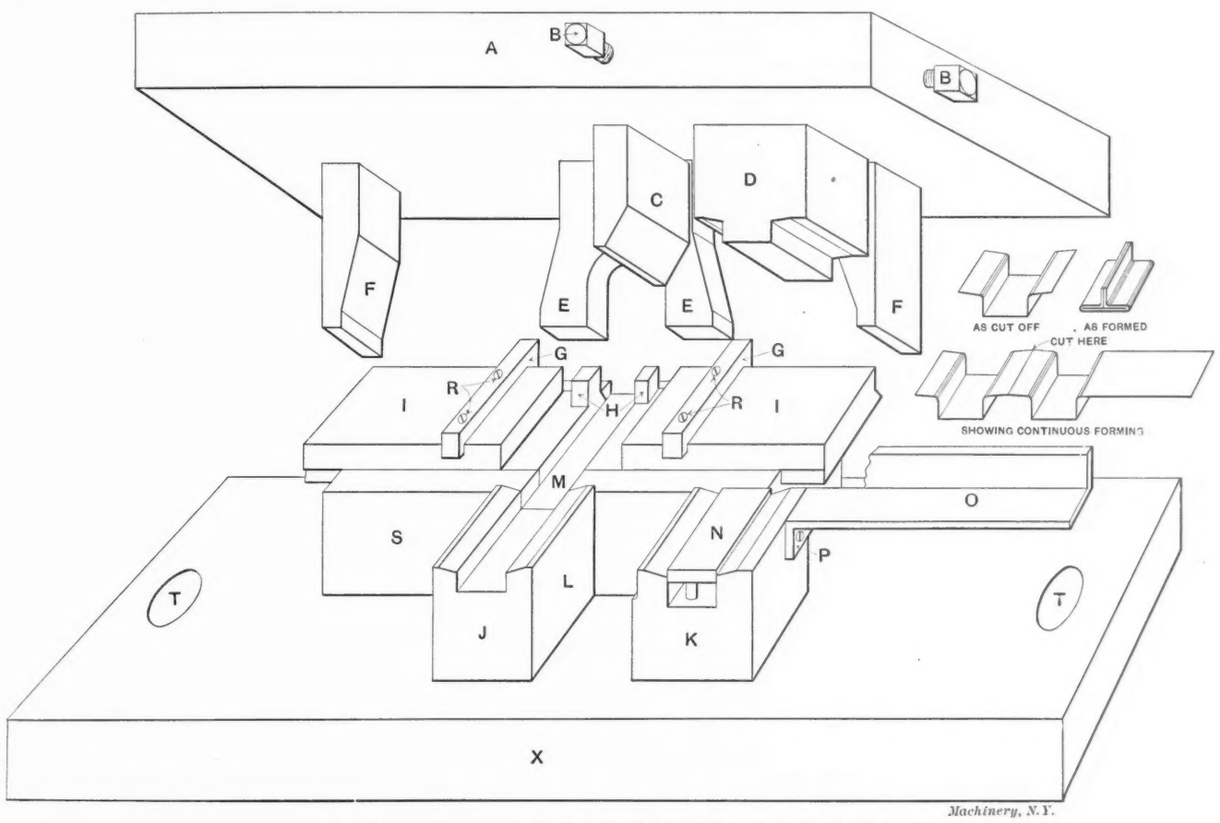
is fastened to the piece *K* by means of two screws, *P*. The upper part will be described further on.

The stock is cut to the desired width on the square shears, and after the stock has been cut, it is placed on the guide, *O*, which keeps the piece in alignment while in the continuous progress of forming, as it is fed into the forming die, *K*. Die *K* is machined to the desired shape, and is cut a little deeper than the piece *J*, to allow of the cushion plate, *N*, being inserted and still give the required depth of the piece to be formed. After the piece to be formed has been placed on the guide, *O*, and shoved to the further side of the forming block, *K*, with about ¼ inch projecting over (that being about the amount of which the metal will draw in), the press is tripped, and we get the first form. The piece is then shoved along until it strikes the block, *J*, on the side marked *L*, which measures off the exact length, 1½ inches, for the next form. The press is then tripped again, and we get the second form as shown in the sketch "Showing Continuous Forming." It is then fed into the block, *J*, which is of the same shape as the piece formed, and the press is tripped again, which gives us another form, and at the same time cuts the piece off, as shown in the sketch, "As Cut-off." This die is worked in an inclined press, and after the piece has been cut off, it is fed by gravity into the closing-in die, *M*. *L* is a cutting face, and *C* is the cutting-off punch. The block is slightly cut away, as shown, to allow of the metal being drawn as equally as possible from both sides. The cutting-off punch, *C*, is left about 1-16 inch longer than the form block or punch, *D*, and cuts the metal off before the metal commences to form; it is tapered as shown so as not to interfere with the other portion of the metal being formed.

After the piece has been cut off, and on the ascent of the ram of the press, the piece slides into the portion of the die marked *M*, and against the pins or fingers, *H*, which prevent the piece from falling through the die until it has been formed. The block, *S*, is made with a dovetailed groove, and the pieces *I* are made a nice working fit therein; the fingers, *F*, which are given the right degree of taper to produce the necessary travel of the sliding pieces, *I*, are of tool steel and hardened, and have ¼-inch taper on the inclined parts. The pieces *G* are tool steel hardened, and are held in place by the screws *R*. The fingers, *E*, are also made of tool steel, and are given the same degree of taper as the fingers *F*. The piece is fed into the die as described, and on the descent of the ram the fingers *F* force the slides *I* inward and form the piece to the desired shape as shown. The fingers *E*, working against the pieces *G*, on the upward stroke force the slides back to their normal position, and the die being worked in an inclined press, the formed piece slides out of the back and a new one slips in. Thus the continuous forming continues until the strip is gone. It will be noticed that there is about ¼ inch left straight on the fingers *F* and *E*, so that they are always in contact with their respective working parts. A portion of the fingers *E* is cut away as shown, so as to allow of the formed pieces sliding through.

This die is fitted to a press having 1¾ inches throw, and is fastened to the bed by means of the holes *T*. The parts *F*, *E*, and *C* are held in position by setscrews, *B*, while the other parts are held by means of filister screws and dowel pins, as one cannot depend on a screw to keep a thing perfectly in its place. The parts *F* and *E* must work in harmony with each other and both have the same degree of taper. *A* is of cast iron, and *J*, *K*, *G* and *I* are all hardened and drawn to a dark straw color. There is also a shank fitted to this die which is not shown, which holds the upper half of the ram of the press while in operation. It will be noticed in the sketch that the piece is formed a little less than right angles, so that in the closing-in operation there is no chance for the metal to spring apart and leave the piece open at the top. There must be allowed twice the thickness of the metal either in the slides, *I*, or the bottom of the die, *M*, for the metal while in the operation of closing in. After the third stroke of the press we get a finished piece every stroke, and they can be made for about three cents per hundred.

Lorain, Ohio. W. VAN ORMAN.



Machinery, N.Y.

Combination Forming Die for Forming Range Fixtures from Sheet Metal.

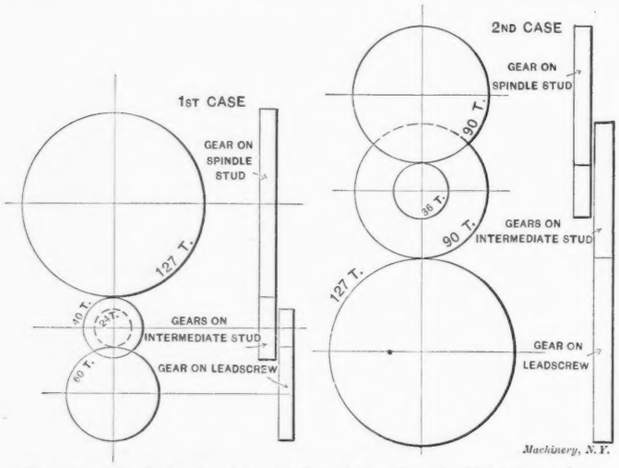
CUTTING ENGLISH THREADS WITH METRIC LEADSCREW.

Editor MACHINERY:

In your February issue I read with much interest an article by Mr. E. Wopalitzky in regard to cutting English system threads, using a metric leadscrew. However, his method seems to me to be rather difficult and uncertain, and the way by means

of which he obtains his result is more complicated than need be.

In the first place, he cannot find the proper gears to use excepting by trial, and having six change gears to deal with, it will require much time and patience to find the correct ones—admitted that *correct* ones could be found; but in the second place, it must be remarked that there is only one way to cut an English thread, using a metric leadscrew and *vice versa*, and that is by introducing in the train of gears a gear with 127 teeth, which will be explained later. As in the case referred to in his article no such gear is used, I cannot see how a correct lead possibly could have been obtained. In the third place, admitted correct results could have been obtained, it seems to me that the expense of making the two studs and



Figs. 1 and 2. Lathe Gearing with Translating Gear for Metric Threads.

arranging them in a suitable manner on the lathe would by far exceed the cost of making a 127-tooth gear, when considering that this gear would always be used in a *single* compounded train when cutting threads of above description; besides, on most lathes, especially on those for smaller work, it would be difficult to find room for a train of more than four change gears. I thought, therefore, that it would be of value and interest to the readers of MACHINERY to get a complete and correct account of the only way possible to cut an English thread by using metric leadscrews and *vice versa*.

1. Metric leadscrew—English thread to be cut.

As there are 25.4 millimeters in one inch, the number of threads per inch on the metric leadscrew equals 25.4 divided by the pitch of the leadscrew expressed in millimeters; in other words, if a is the pitch of the leadscrew in millimeters and C is the number of threads per inch of same leadscrew, then

$$C = \frac{25.4}{a}$$

Let c be the number of threads to be cut on the piece to be threaded, then the ratio of the change gears is

$$\frac{C}{c} = \frac{25.4 \div a}{c} = \frac{25.4}{a \times c};$$

change gears conforming to this ratio will cut an exactly correct pitch. Multiply both denominator and numerator by 5, thus making the formula read:

$$\frac{127}{5a \times c}$$

Thus it will be seen that if a gear with 127 teeth is introduced in the train of gears and other gears are selected, as indicated by the values a and c, the correct change gears can be found without any trouble whatever. For example: Leadscrew has 4 millimeters pitch $= a$; and 5 threads per inch to be cut $= c$.

Then the ratio of gears $= \frac{127}{20 \times 5} = \frac{127 \text{ driver.}}{100 \text{ driven.}}$

If the lathe has a capacity of taking a 127- and 100-tooth gear in a direct train, these gears are used; otherwise, gears have to be compounded and it is readily seen that trains of gears composed as follows:

$$\frac{\text{drivers } 127-24}{\text{driven } 40-60}; \quad \frac{\text{drivers } 127-30}{\text{driven } 50-60}; \quad \frac{\text{drivers } 127-32}{\text{driven } 64-50};$$

and many other combinations will serve the purpose, the gears above being such as generally go with any lathe. The 127-tooth gear in this case ought to be mounted on the spindle stud.

2. English leadscrew—metric thread to be cut.

Suppose d = the number of threads per inch on the leadscrew,
e = the pitch in millimeters on the screw to be cut, and
f = the number of threads per inch of same screw,

then referring to what was said in the first part of the article, $f = \frac{25.4}{e}$ and the ratio of the change gears $\frac{d}{f} = \frac{d}{25.4 \div e} = \frac{d \times e}{25.4} = \frac{5d \times e}{127}$.

Then, as before, it will be readily seen that even in this case a gear with 127 teeth is necessary, and no other gear can replace same, neither in the first case nor in this, as 127 is a *prime factor*. For example: Leadscrew has 8 threads per inch $= d$, 6 millimeters pitch to be cut $= e$; then ratio of gears $= \frac{40 \times 6}{127}$; then trains of gears composed as follows:

$$\frac{\text{drivers } 96-90}{\text{driven } 127-36}; \quad \frac{\text{drivers } 100-60}{\text{driven } 127-25}; \quad \frac{\text{drivers } 80-75}{\text{driven } 127-25};$$

and others can be used in this case; of course the 127-tooth gear ought to be mounted on the screw in this case.

Hartford, Conn. A. L. VALENTINE.

TOOL FOR BORING ROTARY PUMP CASING.

Editor MACHINERY:

Louis Myers.

Fig. 1, next page, shows a rotary gear pump body, built by an automobile concern, and Figs. 2 and 3 show the fixture used in boring same. In this style of pump it is very important that the distance between centers, and the size of bores shall be exact. This fixture can be recommended to do the work satisfactorily, both as regards quality and quantity. The device essentially consists of two parts, the upper part, *A*, being the frame carrying the cutter spindles, and *B* the fixture for holding the pump body. Frame *A* is of cast iron bored to receive two spindles, the distance between the centers of each being exactly the same as in the pump casing to be bored, *i.e.*, 1½ inches. One of the spindles has a taper shank fitted into the drill press spindle, and motion from it is transmitted to the other cutter spindle through spur gears mounted at the lower ends. The gear ends of these spindles are bored to receive the boring cutters, each of which are 1 7-10 inches in diameter for finishing and 1-32 less for roughing. These cutters are of the ordinary four-lipped boring type, made so as to bore and face the bottom, and since the spindles run in opposite directions, it follows that a right and left-hand cutter is required. It is also obvious that they must be so mounted that the teeth do not interfere, since the circles described by the ends of the teeth intersect. As intimated, two sets of cutters are used, one for roughing and one for finishing, 1-32 inch being left for the finishing cut. The face part of the roughing cutters should be ground by hand so as to make the cutting edge irregular, or nicked, in order to allow the cutter to bite freely under the scale and save chipping.

The fixture *B* consists of two cast-iron plates held together

LOUIS MYERS was born in Irkutsk, Siberia, 1871. He came in 1881 to the United States, attended school for a year, and then went to work. He served his apprenticeship with the Pratt & Whitney Co., later had charge of the tool-room of the Searchmont Automobile Co., and is now general foreman with the Cunningham Mfg. Co., Philadelphia. Mr. Myers attended evening school for some time, and now keeps up his study of tool-making by a careful perusal of technical papers.

by four studs at the corners. The guide shafts, *C*, are screwed into the top plate, and the projecting lugs on *A* are bored for a nice sliding fit thereon. The pump casings to be bored are first planed. They are then placed in the fixture with the planed surface against the top plate, as indicated in the cut,

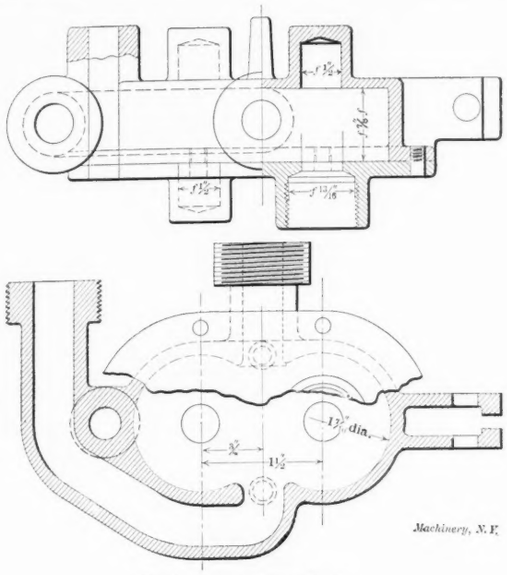
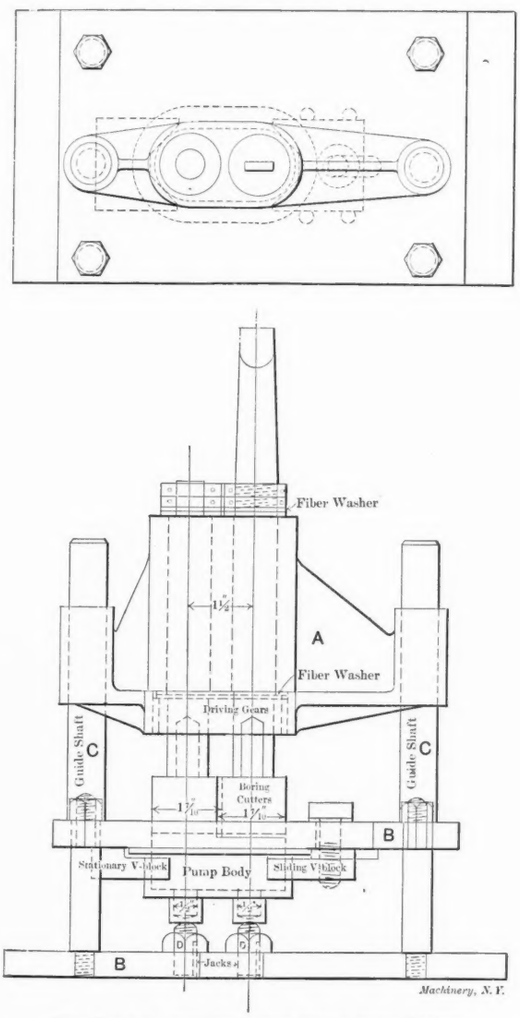


Fig. 1. Rotary Pump Casing.



Figs. 2 and 3. Tool for Boring Rotary Pump Casing.

Fig. 3, one end of the casting being held against the stationary V-block and the other by a sliding V-block. For convenience in operation, the sliding V-block is clamped with a thumb-screw. The two jacks, *D*, are then screwed against the bottom and the work is ready for boring. The ½-inch holes for the ends of the shafts of the pump gears are bored afterward by a separate jig not shown. It consists of a cast-iron plate with two circular locating pads fitting closely within the bored recesses made by the tools, Fig. 3. Half-inch guide bushings are located within the centers of these pads to accurately center the boring tool.

To get satisfactory results with this fixture, it must be made very stiff, the bearings should be long, and the gears and spindles a good fit. It is best to make the bearings of bronze and the gears of good steel. If properly constructed, it will do a surprising amount of work, and will bore a great many castings without any attention from the toolmaker, except in the matter of grinding the cutters, which does not require a skilled operator.

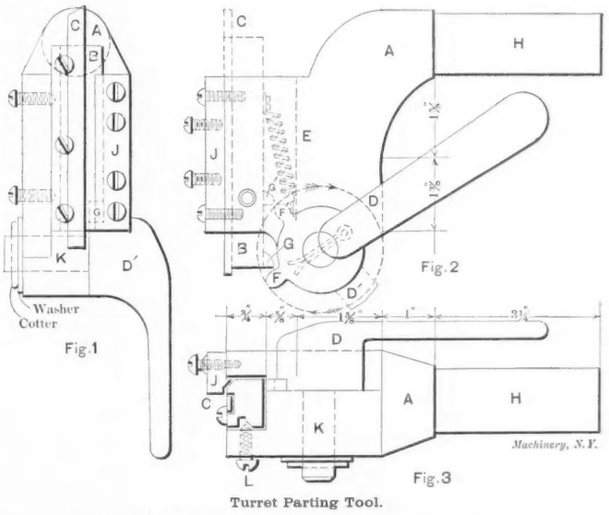
L. MYERS.

Philadelphia, Pa.

A TURRET PARTING TOOL.

Editor MACHINERY:

One objection to the regulation V-block and parting tool used on the turret lathe is the mark it leaves on the work; also the time required to back up the tool, when operated by screw feed. The tool shown in Figs. 1, 2 and 3 was designed to overcome these objections, particularly the one of slow return. The cutting tool *C* is mounted in a movable sliding block *B*, which is attached to a coil spring located in the interior of the casting at *E*. The slide is operated by the lever *D*, which has a cam-shaped tooth at *F;* this cam engages a lug *G* on the slide and forces the tool into the work as the handle is rotated. Fig. 2 shows the tool with the slide clear back, and the dotted lines show the slide forced into the position it should occupy when



Turret Parting Tool.

the point of the tool has reached the center of the work. In this position the cam *F* is just ready to slip off the point of the lug *G* on the slide. The further movement of the handle allows the spring *E* to return the slide instantly to its backward position, and the operator then turns the handle clear round in order to engage the cam on the back side of the lug *G*.

The construction of the tool is simple. *A* is made of cast iron, the end *H* being turned to fit the hole in the turret. The slot for the cam on lever *D* is cored out, a good-sized lug being provided at this point, in which is drilled a hole for the round pin *K* on the lever *D*. The lever is held in place by a washer and cotter key at the bottom. The groove for the sliding tool holder *B* and the spring *E* are also cored out, and the groove, of course, is machined. The slide *B* and tension piece *J* are both made from machine steel finished all over. A half V-groove is planed in the bottom of this slide for the taper point machine screws *L*, Fig. 3, which act as gib screws. There should be no looseness in any of the parts, for smooth close working is an absolute necessity for rapid, accurate work. This tool with a generous oil supply has produced from 3,000 to 4,000 pieces cut off with one grinding of the tool. It is obvious from the construction that the parting tool should be set in the slide *B* so that the cutting point just reaches the center when the lug *G* slips by the point of the cam *F*.

C. NEIL.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO BABBITT CROSSHEADS.

Some classes of engines have a single bar guide, with a crosshead of the enclosed type, three sides of which are babbitt lined. The crosshead is put in place on piston rod and guide and the babbitt poured in. I find it an advantage to coat the guide heavily with white lead before pouring the babbitt. This allows the crosshead to be removed with little trouble and requires but little scraping to get a good running fit.

South Portland, Me. J. V. N. CHENEY.

LOCOMOTIVE BOILER TEST PUMP.

A hand test pump that took six men to operate in relays of three was certainly not popular with the working force. To fill a "long-felt want" a small boiler feed-pump that had been rusting its life away in a dark corner was brought forth, cleaned, oiled and mounted on a light four-wheel truck. With 90 pounds water pressure on shop mains and 100 pounds air pressure at the throttle one man now easily does the work that formerly required six. A. E. MITCHELL.

Malone, N. Y.

TO MEND BROKEN OIL STONES.

A valuable oil stone can usually be saved when broken, even if there should be several pieces. The pieces must first be thoroughly cleaned and all oil driven from the fractured surfaces by heating on a hot iron plate. After the surfaces to be joined are properly prepared, they are well dusted with powdered shellac and again heated until the shellac is melted and flows well into the joints. The heating should be done on a smooth metal plate and the stone kept from the flame; otherwise it is likely to crack in other places. Neither must it be overheated, for the same reason. When the shellac has melted, the parts are pressed together and clamped until they have cooled. A joint so made often lasts as long as the stone, and if carefully made leaves no mar in the cutting surface.

Chicago, Ill. O. M. BECKER.

PLANING ENGINE BEDS.

While looking through a shop in Western Pennsylvania some time ago, I was interested in the planing of center crank engine beds (12 H. P.). The bed was first centered at each end, there being a lug cast on crank end, and as it was of the overhung cylinder type, that end was easily centered. The bed was first put in the lathe and the cylinder end turned; then it was put on the planer bed *on centers*. The bed was trued up with blocking and the planing begun.

The man in charge of same showed me a set of gages. They were made with a round cast-iron base in which was inserted a rod of proper length, and on which was a projecting arm fastened with a screw. The gage was placed on the planer table and the arm indicated if the surface was planed to the proper point. There was no setting of gages for different heights, as there was one provided for each different surface planed; the result was that from six to eight beds were planed in ten hours. F. H. J.

GRADUATING FOR DEGREES IN THE INDEX HEAD.

The following shop kink may possibly be known to a large majority of machinists and toolmakers, but there is always a large number of men who do not know about some one thing that they will want to know about pretty bad some time. It is not every man who knows just how to manage the index head on a milling machine, so as to graduate to degrees. For instance, suppose a machinist is given a job on the milling machine which calls for a finished part on a round piece to be 70 degrees from the first center to the second, 80 degrees from the second center to the third center, 90 degrees from the third center to the fourth center, and 120 degrees from the fourth center to the first, thus making one complete revolution of a circle or 360 degrees.

To proceed with the job, take the index plate which contains the 18-hole circle and arrange the index pin to work in this circle. If there are 18 holes in one complete turn of the indexing handle and it takes 40 turns of the handle to make one revolution of the head, then 40 turns $\times$ 18 holes $=$ 720 holes in 360 degrees. Therefore 720 holes in the complete circle $\div$ 360 degrees in the circle $=$ 2, number of holes on the index plate for one degree. Then to find the number of turns and holes for each number of degrees multiply the 70, 80, 90 and 120 degrees by 2 and the result is the number of holes for each turn of the index head. To prove that this is right:

70 degrees = 7 turns 14 holes.
80 degrees = 8 turns 16 holes.
90 degrees = 10 turns.
120 degrees = 13 turns 6 holes.

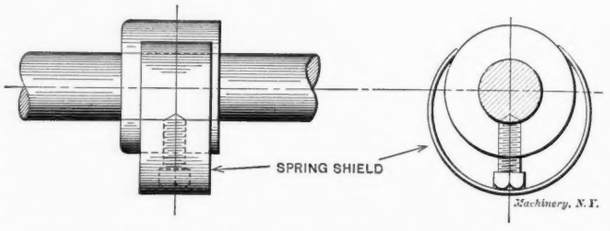
38 turns 36 holes.

38 turns and 36 holes $=$ 40 turns of the index handle or one complete revolution of the index head or center.

Detroit, Mich. C. J. SHAW.

SIMPLE SAFETY DEVICE FOR SETSCREWS.

The blow of the eccentric shield may be felt but the "bite" of the sharp-angled head is effectively muzzled by the thin spring over it; not very pretty perhaps, but likely to save clothes, skin, and possibly bones.



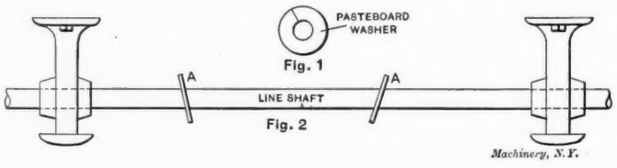
It does not matter where the setscrew is, whether in collar or hub, a piece of sheet steel plate can be curved to fit snug—spring on, in fact—which will keep the head from undesirable interference with stray fingers, belts, clothes, etc., that may wander too near for their good. Then, too, the spring acts as a check and will retain the screw should it loosen. It is just an idea that should be better known for the common good. WARREN E. WILLIS.

Philadelphia, Pa.

SOME POINTS ABOUT OILING—KEEPING A LINESHAFT CLEAN.

For oil holes which are clogged run a red-hot wire into them; this will cause the thick oil, etc., to thin out. Always hold the spout of the oiler a short distance above the oil-hole so you can see the oil dropping in; do not shove the spout down in the hole and take chances for very often you think the oil is getting in when in reality it is doing nothing of the sort.

If you, Mr. Foreman, want to keep your line shafting nice and bright, that is to say, free from dust, simply take two



pasteboard washers, hole to be slightly larger than shaft, and break through, as shown in Fig. 1, then slip over the shaft, two between each pair of hangers. You will see them travel back and forth as long as the shaft is in motion and in so doing they will remove every bit of dust. It is a cheap experiment and well worth trying.

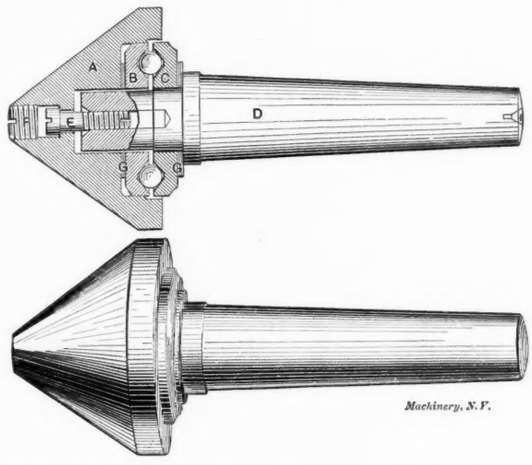
Fig. 2 shows the two travelers, *A*, that only stop to rest when the shop does. ROBERT A. LACHMANN.

Chicago, Ill.

PIPE CENTER.

The accompanying illustrations are sectional and outside views of a pipe center which is rapidly superseding centers similar to that described in the January issue of MACHINERY by J. T. The ball thrust bearing insures absence of slip,

thus reducing the cutting or wearing away of the center or the work when a hollow article is being turned. Referring to the sectional view, the ring or race *B* is firmly attached to the cone center *A* with which it revolves; the race *C* is affixed to the shank *D*, which of course is fitted to the spindle of the lathe footstock. The parts are held together by the



filister-head screw *E*. Hard fiber washers are inserted at the back of the races to prevent a too harsh contact of the balls and the races. The screw *F* prevents the admission of dirt to the interior.

This center is made by Chas. Taylor, of Birmingham (Eng.), the well-known chuck and machine vise specialist.

Birmingham, Eng. FRANCIS W. SHAW.

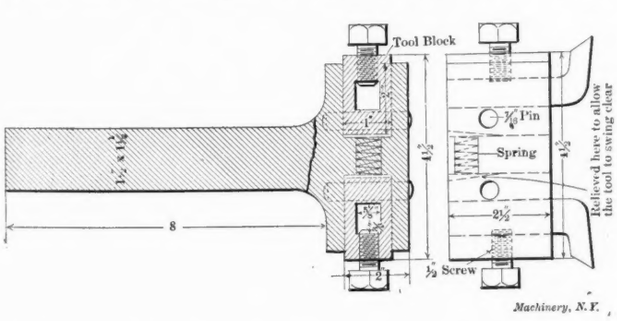
HANDY WATER CONNECTION FOR CAR WHEEL PRESS.

The following method of connecting water supply to a wheel press pump may be of interest. The city water pressure here is about 90 pounds; it is connected directly to the suctions of the pump with a ½-inch cut-out cock convenient to the attendant's hand. By simply opening the cock the ram is rapidly advanced to the end of the axle and all lost motion is taken up before starting the pump into action. When the axle is nearly out of the wheel the city water pressure on the ram is then sufficient to remove the axle much quicker than the pump could. This kink has been found very effective as applied to an old-style wheel press here. A. E. MITCHELL.

Malone, N. Y.

DOUBLE-HEAD TOOL FOR PLATE PLANERS.

I send you a sketch of a double-head tool for use on plate planers for planing surface work on structural or boiler plates; also on boiler patches, this enabling the planing to be done, each way of travel of head and doing the work in one-half the time. I recently visited a shop which had a plate planer some 18 feet long, on which a surface 6 or 8 inches

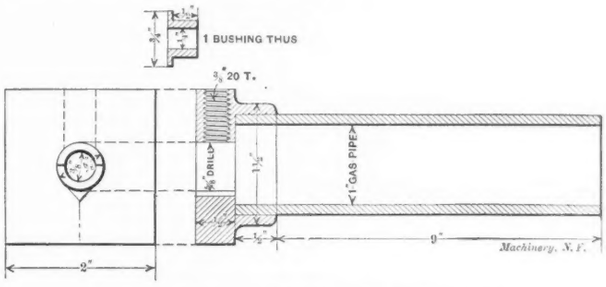


wide on a plate was being planed with a single tool, the tool being raised on the return stroke, thus losing one-half the capacity of the machine. I have seen the tools shown in cut in use for years and know it works well; it is certainly a timesaver on that class of work when used on plate planers.

TOOLMAKER.

HOLDER FOR GRINDING SQUARES ON SETSCREWS, ETC.

The cut shows a handy little device for grinding squares on small taps, reamers, setscrews, etc. The sides of the square part of the holder being large and resting on the emery wheel table a tap or any small round thing can be accurately



squared up in a jiffy. A half-bushing can be inserted for smaller sizes. Of course this holder could also be made for larger work but the large work would probably be machined anyway. ARTHUR MUNCH.

St. Paul, Minn.

MICROMETER GAGE FOR MILLING CUTTERS.

I send you a sketch of a gage now made by J. E. Reinecker, Chemnitz-Gablenz, Germany. It has the advantage over those formerly made by the same manufacturer, for testing cutters, that each tooth can be tested separately as regards its length measured from the center of the mandrel. This is a very good feature, as a non-circular cutter very much reduces the capa-

city and quality of output of the milling machine; and further, by reason of the unequal strain on the teeth, some of the longer ones are apt to break. The centering of the gage is effected by disks accurately fitting the cutter bore, entirely independently of the key slots. ROBERT GRIMSHAW.

Hanover, Germany.

* * *

The sense which enables us to judge of the perpendicularity of objects is well developed in most persons, and is more or less reliable under ordinary conditions. There are conditions under which it is deceptive, as for instance, when a train is rounding a sharp curve the trees and buildings will appear to lean outward toward the observing passenger, if he is on the inside of the curve. The reason is that the elevation of the outer rail of the track, to compensate for the effect of centrifugal force, is usually such that at normal speed a plumb line suspended in the middle of the car would hang midway between the tracks, and of course the persons standing or sitting adapt themselves to the component of the vertical force of gravity, and the horizontal effect of the centrifugal force. Hence they refer all objects to their latent sense of erectness, thus making buildings and trees appear to stand out of plumb.

SHOP RECEIPTS AND FORMULAS.

Practical Tried Receipts—those known to be Good—are Solicited.

TO WRITE BLACK ON GLASS OR BRIGHT METAL.

To write black on glass or bright metal, use 1 to 2 parts of silicate of soda with 10 parts of India ink. Write with a steel pen.

F. H. JACKSON.

Angelica, N. Y.

MIXTURE FOR MAKING A POROUS CASTING AIR- AND WATER-TIGHT.

To make a porous casting air- and water-tight prepare a saturated solution of copper sulphate, mix with it an equal quantity of commercial nitric acid. Dip the casting into the solution, or pour it over the casting on all sides and let stand for a few hours.

L. S. BURBANK.

Worcester, Mass.

BLACKING BRASS.

For blacking brass I find nothing superior to chloride of antimony. The articles should be thoroughly cleaned and polished, then immersed in the solution for a short time, and dried over a spirit lamp; then brush with a black lead brush.

Angelica, N. Y. F. H. JACKSON.

NON-RUSTING SOLDERING FLUID.

To make a non-rusting soldering fluid, dissolve small pieces of zinc in hydrochloric acid till effervescence ceases. After standing a day, take out the undissolved zinc, and filter the solution. Then mix with one-third its volume of C. P. ammonia, 26 degrees, Beaume, and dilute with water to suit the work to be soldered. This flux does first-class service and does not rust the work.

F. E. WHITTLESEY.

Corry, Pa.

STEEL HARDENING AND TEMPERING COMPOUND.

I would submit the following formula as an excellent compound for hardening and tempering steel. We have tempered flat cutters, Acme and U. S. standard taps, counterbores, reamers, etc., to our entire satisfaction, without drawing the temper in any of them: To 10 gallons of soft water, add 5 teacups salt, 6 ounces saltpeter, 12 teaspoonfuls of powdered alum, and 1 teaspoonful corrosive sublimate.

H. S. HINDMAN.

Columbus, O.

INSULATING COVERING FOR STEAM PIPES AND BOILERS

To one barrel of lime use six barrels of sawdust. Slack the lime in an ordinary mortar bed, and when slacked mix in the sawdust, using enough water to make it of the consistency of mortar. Apply when the steam is on. This covering is adapted for steam pipes and boilers, more especially in sawmills and other places where a box can be built around the pipe so as to hold the mixture in place. It is approved by insurance companies.

THEODORE DISCH.

Milwaukee, Wis.

PROCESS FOR PULVERIZING BORAX.

To a two-gallon pail of boiling water add as much borax as will dissolve, and a surprising amount will dissolve—12 to 15 pounds in two gallons of water. When as much borax is added to the boiling water as will dissolve, set the pail in cold water, running water preferred. Stir contents vigorously, which will in a few minutes form into a thick mass; spread this out thin on some smooth surface, as tin, where it will soon dry to flakes which, when handled, will crumble to dust. This process is employed here at the Rock Island arsenal.

Moline, Ill. ALBERT D. KNAUEL.

ETCHING SOLUTION.

The etching solution made by the following formula has an advantage over other etching solutions in that it will not rust the most highly polished steel, and it is not in any way injurious to the hands or clothing—as a matter of fact the hands can be dipped into it with no ill effects. Mix 6 ounces distilled water; 4 ounces sulphate of copper; 4 ounces chloride of sodium (common salt); 1 dram sulphate of zinc; ½ dram sulphate of alum. The solution is applied in the following manner: The piece to be marked is covered with melted beeswax, and the inscription to be etched is marked through the wax with a fine pointed tool, leaving the wax undisturbed save where the marking is to appear. The markings are then filled with the fluid and allowed to stand for three hours. The result will be a very sharp and distinct lettering.

Philadelphia, Pa. L. MEYERS.

TO PREPARE IRON OR BRASS FOR LAYING OUT WORK.

To coat the finished surface of iron and steel with a copper film to facilitate laying off work, make a solution of sulphate of copper and apply to the work with a piece of clean waste; the copper film shows up the lines very plainly. This solution can also be used on brass by simply sprinkling iron filings on the brass surface, and then applying the copper sulphate solution. The surface to be coated should in all cases be free from oil, grease, etc.

OLIVER E. VORIS.

Dayton, O.

TO HARDEN CAST IRON—TO KEEP WATER FROM FREEZING OR SOURING.

To harden cast iron take ½ pint vitriol (sulphuric acid), 1 peck common salt, ½ pound saltpeter, 2 pounds alum, ¼ pound prussiate potash, and ¼ pound cyanide potash, dissolve in 10 gallons of water. Heat iron to a cherry red, dip, repeating until hard enough.

To keep water in fire barrels from freezing or becoming sour, dissolve 1 peck common salt and a lump of unslacked lime, say about 8 inches diameter, in each barrel.

Harrisburg, Pa. W. T. SEARS.

LUBRICATING SOAP FOR WIRE DRAWING, SCREW CUTTING AND WORKING METALS.

Put 20 pounds of pure caustic potash into an iron or earthen vessel with 2 gallons of water. The potash will dissolve very quickly by heating the water. Heat 9½ gallons of oil to about 140 degrees F., which is most easily done by bringing a small portion of the oil to the boiling point and adding this to the remainder. Pour the caustic potash lye into the oil in a small stream, stirring steadily with a wooden paddle until the oil and lye appear well combined and smooth, which will take only a few minutes. Put the mixture in a warm place, covering the vessel well with blankets or woolen rugs to keep in the heat caused by the mixture combining and turning into soap. This wrapping is very important, the object being to keep the temperature uniform until saponification is completed. The mixing may be done in a wooden vessel, half an oil barrel answering very well. After three or four days the soap is formed and may be used, though it is better, in order to insure perfect saponification of all the oil, to stir it up well again and leave standing, still well covered, for a few days longer. In this way the finest possible soap for lubricating purposes is made. It is a real potash soap made pure for use, not made cheap for sale by the addition of water and impurities, and, moreover, cannot be excelled for cleaning or washing purposes, especially for washing flannels, and will never cause sore hands.

Use a first-class pale seal oil for soft soap for wire drawing, though a good, refined cotton-seed oil may be used for general purposes. It is absolutely necessary that the caustic potash be unadulterated, for the principle of this cold process of making soap depends on the use of strong, pure lye of caustic potash.

The best way of making the suds with this soap is as follows: Put 6 pounds of the soap into a vessel with 2 gallons of hot steam water, heat to thoroughly dissolve the soap, stirring well, then add 6 more gallons of water and lastly 3 gallons of oil, which should be thoroughly stirred into the soap and water, so that on standing over-night the oil will not separate. This will be found to give very good results.

The cost of this soap depends on the quality of the oil and whether wholesale or retail prices are paid. Even at the latter it will not exceed 7 cents per pound. With cotton-seed oil and wholesale prices it can be made for about 5 cents, which would be equivalent to ordinary soft soap bought at 2½ cents per pound.

A. F. BIERBACH.

Milwaukee, Wis.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

37. A. L. K.—Suppose I make an end gage of ¼-inch tool steel drill-rod to exactly fit a cast steel locomotive driving wheel bore 10 inches diameter, and do the job out of doors with the temperature at the freezing point, being careful that the temperature of the drill rod falls to that of the wheel. When brought into the shop such a gage expands about 0.002 inch in length. Will it be safe to turn the axle to the end-gage size, making the usual allowance, of course, for a press fit? In other words, will the drill-rod and wheel center expand and contract with changes of temperature at the same rate?

A.—If you make sure that the drill-rod gage is no warmer than the wheel center when the fitting is finished there should be no trouble in using such a gage for getting the size of the axle fit. It is true that cast steel and tool steel do not change exactly the same for variations in temperature, but the difference is small, the coefficients being about 0.00000636 and 0.00000689 for cast and tool steel respectively. This would mean a difference in expansion in a rise of 30 degrees F. of about 0.00015 inch for 10 inches. These figures are not exact as various authorities do not agree on the coefficients for various metals, but the result given above is not far out of the way.

38. Inquirer.—What are the proper proportions for a cast-iron spring piston ring of unequal thickness, that is, of the eccentric type, and the proper amount to be cut out of the thinnest point, in order that a tight joint may be made when the ring is sprung over the piston?

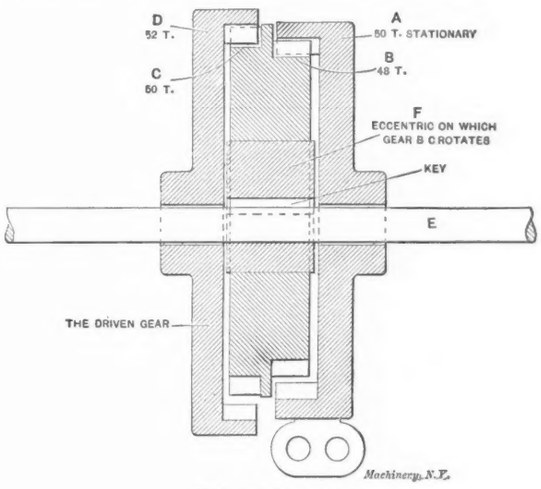
A.—This problem is worked out in Unwin's Machine Design, where for uniform pressure on the surface of the cylinder a ring is arrived at which varies uniformly from a thickness at the thickest point of $t = 0.04$ to $0.06r$, where r is the radius of the ring when sprung into the cylinder, to nothing at the ends, opposite the thickest point. The outside radius of the ring initially is $1.1r$; about 2-3 of the inside curve of the ring agrees very closely with a circle struck off from a point distant $0.206t$ from the center of the outside of the ring. The ring is accordingly bored out eccentrically to a radius $r - 0.794t$ and the points near the thinnest part of the ring are still further thinned out. While theoretically correct, this construction will not do in practice, because the thin part of the ring wears away the groove in the piston. Prof. John E. Sweet, of the Straight Line Engine Co., Syracuse, N. Y., informs us that the practice of the latter company is to make snap rings practically 1-48 larger than the cylinders, so that the ring for a 9-inch piston is turned 3-16 inch larger than the cylinder and bored eccentric so as to leave the rings from ¼ to 5-16 inch thick at the thick part, and ⅝ that thickness at the ends. If a tight joint is to be made when the ring is sprung over the piston the amount to be cut out would be in the case of the ring for the 9-inch piston above mentioned $9\ 3\text{-}16\ \pi - 9\pi = 0.589$ inch.

39. F. J. C.—I am making a model epicyclic gear of the form shown in the cut which is said to give a speed reduction of 625 to 1. Gear A is stationary and will have 50 teeth; B and C are cast together and turn as one, B having 48 teeth and C 50 teeth; D is the driven gear and has 52 teeth. The gear BC is mounted on an eccentric, F, keyed on the shaft, E. I wish to make a gear that will give a velocity ratio of 644 to 1; what are the rules for calculating the speed reduction, and for finding the numbers of teeth of the gears that will give a desired ratio?

A.—There are several methods of solving problems in epicyclic gearing, but the one given herewith is, perhaps, most frequently used in applied mechanics as it is simple and requires less mental gymnastics than the others. We first consider the shaft, E, as being stationary and gear A turned around once in a right-hand or + direction. The velocity ratio of the driven gear, D, and the intermediate gear, BC, is found, of course, the same as for any simple train of gearing, and is that given in the first line of the table. Since all the gears turn in the same direction the ratios all have the + sign. Now if we lock all the gears together and turn shaft E in a left-hand or — direction one turn, it is apparent that all the gears are given one turn backward since they turn with the shaft, hence the second line of the table:

	A	B and C	D	E
Shaft E stationary and gear A rotated one turn.	$+1$	$+\frac{50}{48}$	$+\left(\frac{50}{48}\times\frac{50}{52}\right)$	0
All gears locked together and rotated around common center one turn ...	-1	-1	-1	-1
Algebraic sum	0	$+\frac{2}{48}$	$+\frac{4}{2496}=\frac{1}{624}$	-1

From the above it will be seen that gear D turns 1-624 revolution to one turn of shaft E, and in an opposite direction since the signs are opposite. Hence the velocity ratio is 624 to 1



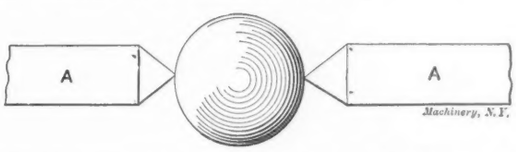
Epicyclic Gear Train.

instead of 625 to 1 as you state. The ratio 644 to 1 may be obtained with gears 60, 56, 43 and 46, instead of gears 50, 48, 50 and 52, but arranged in the same order. We know of no rule for finding the gears of an epicyclic train which shall give a required ratio; they must be found by a process of selection, keeping in mind desired relations of gears, numbers of teeth, etc. See MACHINERY, September, 1900, page 25.

* * *

ALLEGED METHOD FOR BALANCING BALLS!

In a fearful and wonderful article on ball bearings of automobiles published in an automobile paper some months ago, a writer who should be well known because of the fake mechanical stuff which he has palmed off on unsuspecting editors of trade and other class papers tells of some astonishing failings of this type of bearing, and gives equally astonishing methods of repair. No one else would have dreamed that ball bearings had the vicious, depraved habits attributed to them by this writer; neither could they, we venture to say, have imagined the methods of repair he has devised for them. As an instance of his mechanical prowess, we reproduce his



method of ascertaining whether steel balls are in balance. Any mechanic will at once perceive the depth of this gentleman's knowledge. He says that a plan for testing balls for proper balance is shown in the cut. The scheme consists in using the two points, $A\ A$, which points are part of the tool system of a gage. They are fixed in shouldered hubs in which there are blocking threads (whatever that may mean), and by these threads the stubs can be set to prick the balls in their centers and hold the ball in place while it is revolved to ascertain where the ball is out of balance, if at all out of balance. Defects located can be rectified. Very defective balls are thrown out! If there is anything worse than this on record, we have yet to see it.

MACHINERY AND TOOLS.

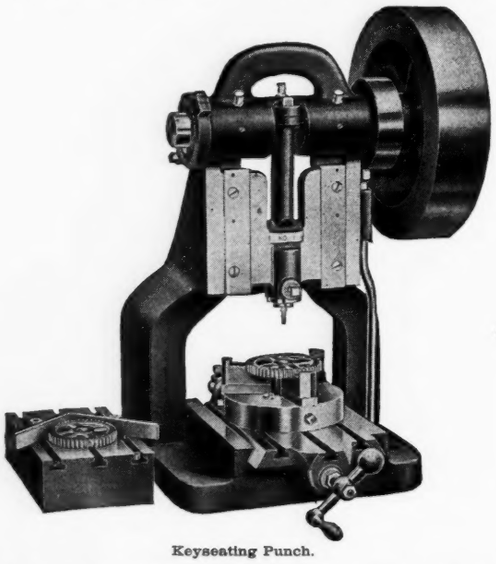
A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

IMPROVED PLAIN RADIAL DRILL.

The half-tone given below illustrates an improved plain radial drill manufactured by Roos & Mill, Cincinnati, O. Simplicity and sufficient rigidity for the use of high-speed tool steels have been the chief ideas in the design of this tool. The main column is cast in one piece with the base, and supports at the top and bottom a heavy secondary column on which the

Plain Radial Drill.

arm is mounted. The arm has a box girder shaped cross section and numerous inside ribs. It is elevated and lowered by power and easily locked to the column. The spindle has eight changes of speed, hand and power feed, automatic and safety trip, and a quick-return movement. The drill is arranged for tapping, the mechanism therefor being located on the head at the back of the arm, and operated by a handle near the lower



Keyseating Punch.

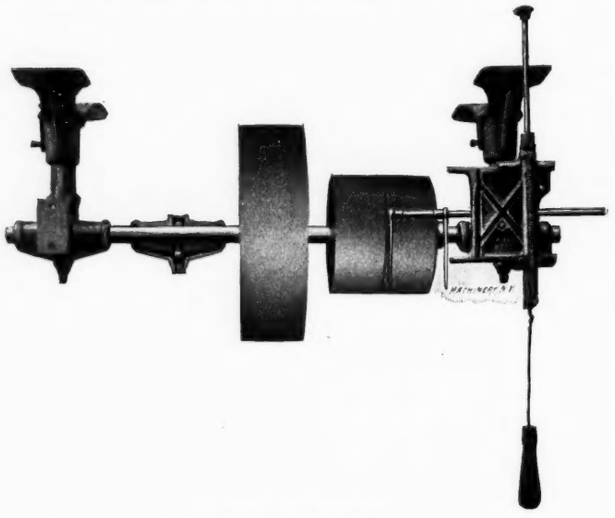
end of the spindle. It is fitted with adjustable friction clutches which will draw tight proportionally to the power required. The back gears and high-speed gears engage directly with the spindle, thus relieving shafts, gears, and couplers from heavy strain. The main column in the 3-foot radial drill is 15½ inches square at the bottom. The arm column is 5½ inches in diameter, and the arm has maximum vertical range of 2 feet 7 inches. The spindle has a horizontal range of 2 feet 6 inches, and a vertical range of 12 inches. Its smallest diameter is 1 11-16 inches and its largest 3 inches. It is, in the 3-foot radial drill, bored to fit a No. 4 Morse taper. The machine receives work 4 feet 6 inches high under the spindle and over the base, and the drill works on the base to center of 7 feet 10 inches, and over table to center of 6 feet.

KEYSEATING PUNCH.

The keyseating punch illustrated below is designed for light internal keyseating, cutting keyways from ⅛ inch up to ⅜ inch wide. The sliding table is operated by a ball handle and screw. The table has three ½-inch T-slots, and is furnished with or without a chuck for holding work. The subtable, as shown, has three ½-inch T-slots and a V-block. The over-all height of the punch is 28 inches, and the length of stroke 1½ inches. The size of the sliding table is 5¾ by 11¾ inches and its longitudinal movement is 2½ inches. It is made by the B. F. Barnes Co., Rockford, Ill., who first built it for their own use in cutting keyways in small gears, etc., some two years ago. It is now placed on the market for the first time.

A ONE-PULL POSITIVE LOCK BELT SHIFTER.

The Diamond Clamp and Flask Company, Richmond, Ind., have gotten out a belt-shifting device, here illustrated, by which a machine run from the fast and loose pulleys on the countershaft may be started by simply pulling the cord shown, and then stopped when desired by pulling the cord again. The



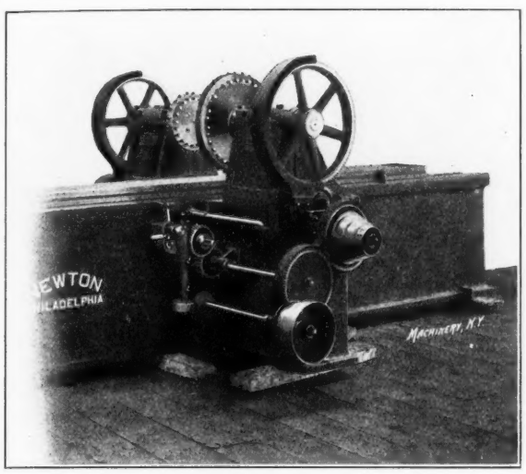
Positive Lock Belt Shifter.

shifter locks itself in position either way. The chief feature of the device is the shifting plate which carries the shifter fingers, and which, as shown, has two vertical grooves on its face, and two diagonal grooves that intersect the vertical grooves toward the top and bottom of the plate. The frame consists of one piece having two half-round guide ways on the ends for the shifter plate, and also guide ways at right angles to these for the pull rod. The bottom is slotted so as to be bolted to a hanger or other convenient support. Swiveled in the pull rod is a diamond-shaped nut, which is held normally at the top of one of the vertical grooves in the shifter plate by a tension spring. By pulling the cord of the pull rod the nut follows down the vertical groove until it strikes the offset of the groove at the bottom of the plate, which switches it off into the intersecting diagonal groove. The shifter plate is moved forward when, on releasing the cord, the diamond-shaped nut is returned to the top of the plate by the tension of the spring, the nut being guided by the diagonal groove, thus shifting the belt onto the other pulley. The nut

is now held in position at the top of the second vertical groove by the spring, ready to reverse the motion by means of the other diagonal groove upon the next pull of the cord. A special plate is of course required for each width of belt, so that each frame is provided with shifter plates that can be substituted for any width of belt desired. The countershaft has universal adjustable hangers, and carries a swivel box with ring oiling device.

SPECIAL DUPLEX MILLING MACHINE.

The illustration shows a duplex miller specially designed by the Newton Machine Tool Works, Philadelphia, for milling grate bars for mechanical stokers, the large cutter milling the flange side of the bar, and the smaller cutter recessing out the opposite side. The large cutter head is 20 inches in diameter,



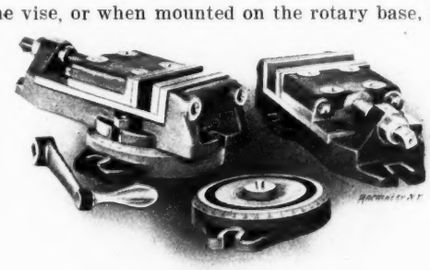
Duplex Milling Machine.

and the smaller one 12 inches; these cutter heads are fitted to spindles 4 inches in diameter, and are driven through gearing by a 4-inch belt, operating through tight and loose pulleys, the gearing being so arranged that the peripheral speed of the cutter heads is equal. The carriage is 12 inches wide and 13 feet 3 inches long, to mill work 12 feet long.

The carriage is operated by a screw and has four changes of automatic feed and power quick traverse, the automatic feed to the table being controlled through stops. The cutter heads are arranged to give a maximum distance of 12 inches between the tools, each head having 1 inch of adjustment. The spindle head for the smaller cutter is arranged to have an automatic in-and-out movement operated through stops, so that the head can be fed into the cut or withdrawn from it at any position.

NEW MILLING MACHINE VISE.

The Becker-Brainard Milling Machine Company, Hyde Park, Mass., are making a new model vise in sizes having jaws from 5 inches to 8 inches wide. It may be used as a plain milling machine vise, or when mounted on the rotary base, as a rotary



Milling Machine Vise.

vise. The rotary base is graduated for fine adjustment. To mount the vise upon this base it is merely necessary to insert two bolts. All parts are machined in fixtures and jigs, and are hence perfectly interchangeable. Strength is especially provided at the face of the lower jaw by the distribution of the metal and the strong ribs on the under side. It is particularly made for use with milling machines, but is also adapted to be used with drill presses, planers, etc.

GRANT RIVET SPINNING MACHINE.

The machine shown in the accompanying cut is designed for spinning heads on the shanks of rivets, as distinguished from forming the heads by blows of a hammer or machine. The part to be riveted is placed head down on the anvil of the machine, when pressure on the foot treadle forces the rapidly revolving spindle downward, causing the spinning rolls, which are formed for the shape desired, to spin a head on the shank of the rivet. The spinning rolls are made in halves, each the counterpart of the other, and are interchangeable in the roll holder. Heads may be rolled of a conical, or of a full half-round shape, or with an arc of a circle of any dimension.

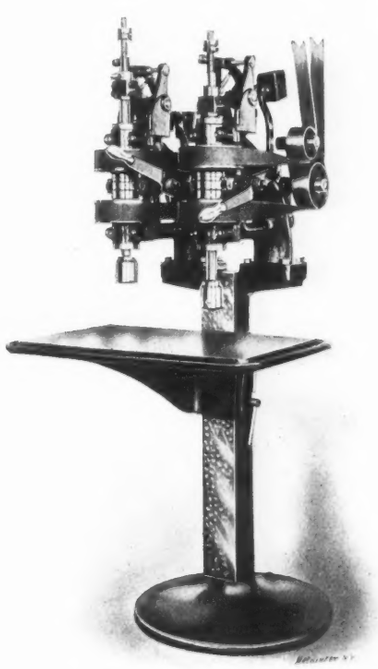
Grant Rivet Spinning Machine.

The finished head is smooth, and as there is no upsetting action, shoulder rivets or rivets closely fitting holes in parts to be riveted may be securely headed without danger of binding the parts when a flexible joint is required, as is often the case in typewriters, adding machines and other mechanisms.

The capacity of the machine is for ¼-inch rivet shanks and smaller. The distance from the back of the throat to the center of the rolls is 4 inches, the adjustment of the anvil 1¼ inches, the width of the belt 1¼ inches, and the bench space required is 10 inches wide by 15 inches deep, by 23 inches high. The machine is made by the Grant Mfg. & Machine Co., Bridgeport, Conn.

DUPLEX VERTICAL TAPPING MACHINE.

The Grant Mfg. & Machine Co. have also brought out a duplex vertical, automatic, tapping machine designed to meet the special requirements found in typewriters, adding machines and similar work, the table being of such proportions as to provide ample bearing surface for large frames.



Duplex Vertical Tapping Machine.

The distinctive novelty of this machine is the engaging of the forward driving friction by an upward movement of the operating lever. In most similar machines the engagement is made by a downward motion of the lever, which necessitates care to prevent the tap from diving into the hole. Another

distinctive feature is that the height of the spindles in relation to the table may be staggered, which is of value on work where the holes are on different planes, thus doing away with the necessity of blocking up work to place it in correct position with a spindle. This feature gives the machine increased capacity, holes being tapped from ⅛ inch to ½ inch. The table is 16x26 inches; the distance from center to center of the spindles 10 inches, and the distance from the chuck to the table when down, 26 inches; the distance from the face of the column to the center of the spindle is 10 inches. A 2-inch belt is used and the floor space required is 30 by 36 inches. These machines are also made with any number of spindles required.

WALCOTT RACK CUTTING MACHINE.

The rack cutter shown in the accompanying cut is a recent design made by George D. Walcott & Son, Jackson, Mich., to meet the demands of rapid work in using high-speed steels. This machine cuts racks 32 inches long and 8 inches wide, three-pitch or finer, without resetting the work. It is intended

Half Automatic Rack Cutter.

to take cutters 6 inches in diameter with 1¾-inch holes, but the same machine is furnished with cutter arbor, boxes and gearing so changed as to admit of the use of Brown & Sharpe standard cutters, as used on their No. 4 and No. 5 automatic gear cutters. The various parts of the machine are heavy, the top housing being 2 inches thick; the bearings for knee, cross rail, and table are all of the square lock pattern, and are wide and strong. The table is 14 inches wide and 33 inches long.

The driving mechanism consists of a train of seven gears and pinions, giving a ratio of 23½ to 1, driven by a 4½-inch belt running on a three-step cone between the housings. The pinions on the cutter arbor, intermediate, and first intermediate shaft are of steel; all bearings are bushed, those of the cutter arbor being provided with special bronze.

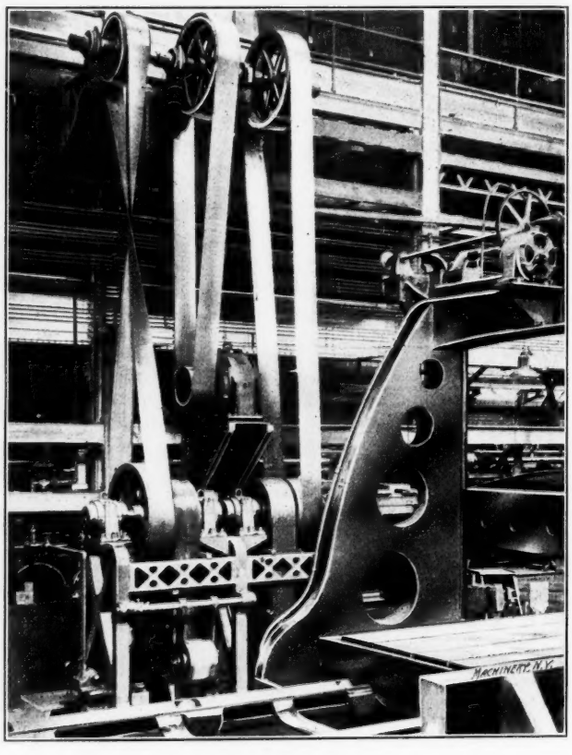
Changing the cutters is done by loosening the two bolts in the T-slot and sliding the bearing out endwise, when the cutter clamping nut may be removed and the cutters changed. Indexing is done by means of the handwheel and locking device shown immediately behind the handwheel, the only gear changed for the various pitches being that on the lead-screw. Two or more finishing cutters with two or more roughing cutters on either side are used so that the work may be changed and the table indexed in the opposite direction without traversing the entire length of the table for a new setting.

The feed shaft is carried in swivel bearings, the one on the right-hand side of the machine being held up by the latch when the worm is engaged. Four feeds, of .087, .125, .187 and .262 inch per revolution of cutter, are provided by four-step cones and belt on the left-hand side of the machine, the lower cone being on the end of the feed shaft. The feed cones are connected by an adjustable belt tightener, which maintains a constant tension on the belt for all positions of the table. The upper feed cone is carried on a swiveling yoke, and is driven by spur gearing from the pulley shaft. The elevating screw is provided with an index reading to thousandths for setting the depth of cut. The machine is so constructed that it may be run in either direction to accommodate special work, the automatic trip for throwing out the feed on completion of the cut operating in either case.

The cutter speeds for ordinary tool steel are 20, 30 and 40 revolutions per minute. With high-speed steel 32, 46 and 66 revolutions are intended to be made. The countershaft is run at 300 R. P. M. for ordinary cutters, and 415 revolutions for high-speed steel.

A MITCHELL PLANER DRIVE AT THE WESTINGHOUSE WORKS.

A Mitchell planer drive, the first of its kind installed in the United States, is shown in the accompanying cut as used in the works of the Westinghouse Electric & Mfg. Co. at East Pittsburg, Pa. The drive operates as follows: Two independent countershafts are supported on a framework attached direct to the planer. These countershafts may be either belt driven, as in this installation, or gear driven. From the forward and reversing pulleys on these countershafts, belts hang loosely over the pulleys on the main driving shaft. Idler pulleys, pivotally supported, may be actuated by the table, to press against the loose side of either of these belts, and so bring that belt in contact with a main driving shaft pulley. The idlers may be operated either by air or direct from the planer table. In the illustration herewith the operation is by air, levers actuated by the table dogs operating the air valve seen in the lower left-hand corner of the cut, so as to admit air to either side of a plunger, which accordingly swings the idler pulleys in the proper directions for forward or back driving.



Mitchell Planer Drive.

By this method the jar may be greatly reduced. The drive may be attached to existing planers, increasing their speeds from two to three times. It can be designed for variable cutting speeds, and any width of belt desired may be used. The drive here shown is run by a constant-speed Westinghouse motor of 40 H. P., running at 720 R.P.M. The representative of the device in this country is A. Burchard, 321 Savannah Ave., Wilkinsburg, Pa.

AN OSCILLATING MILLING MACHINE.

The accompanying illustrations show an oscillating milling machine which the Hendey Machine Co., Torrington, Conn., are introducing. It is intended to be used on work which in most cases presents points for finishing that are difficult to reach with the tools of the ordinary milling machine, shaper or slotter. The miller may be advantageously used for plain

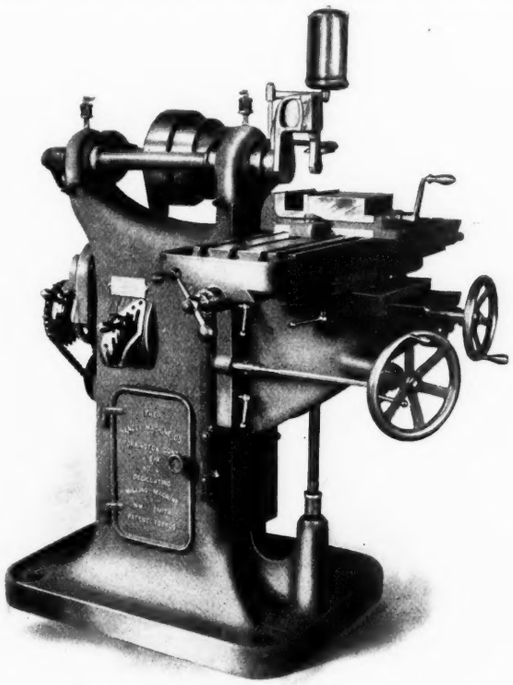


Fig. 1. Oscillating Milling Machine. Adaptation of Regular Milling Machine Design.

slotting, and for such operations as the facing off of the inner sides of bosses which would be awkward for a bar with a facing cutter and difficult for an ordinary slotter.

The principle on which the machine operates is a very interesting and, as far as we know, an entirely novel one.

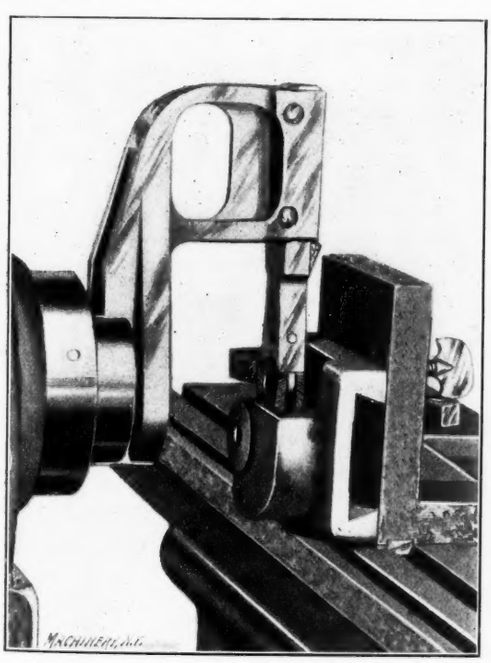


Fig. 3. Oscillating Miller Facing the Bosses of a Casting.

Fig. 1 shows an adaptation of the design of the makers' regular milling machines, while Fig. 2 is a design especially made for the oscillating miller. The machine consists essentially of a driving shaft carrying on its rear end a movable wrist plate and pin, which is connected to the main spindle of the machine by means of a hollow connecting rod. This connecting rod is attached to a yoke on the main spindle at the back of the machine, so that the rotation of the driving shaft imparts an oscillating motion to the main spindle, the amount of this oscillation being regulated by the movable wrist plate and pin. The cutter head may be either a part of the main spindle, as in Fig. 2, or a separate fixture, as in Fig. 1, in which case it is centered and held in place by a drawing-in bolt. The cutter is made with a suitable shank which is dovetailed to the cutter head, and is of such length that the axis of the cutter is in true alignment with the axis of the main spindle; hence the oscillating motion of the head leaves the axis of the cutter fixed in position, the cutter being given a partial forward and back rotation about it as though its axis were a real arbor. The cutter is always in contact with its work regardless of the direction of stroke, hence the teeth of the cutter are milled radially from the center with no clearance in either direction, and may be of V-shape or a flat form of tooth which may be ground across its face, giving it a double cutting edge, this latter form being preferred for cutters of large diameter.

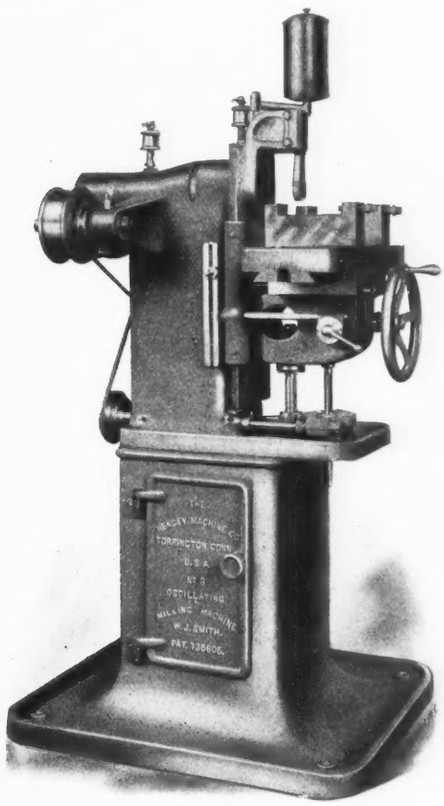


Fig. 2. Milling Machine Specially Designed to Operate on the Oscillating Principle.

Fig. 3 shows an oscillating miller facing the bosses of a tool post casting; the average time for chucking the work and finishing both sides of the boss of this piece was 4½ minutes. Fig. 4 is an example of the milling of a semi-circular groove. All slotting work on the oscillating machine, as the tool post work mentioned, must first be drilled out by a jig to remove the stock, since as the cutter does not revolve and so clear itself, it is not intended to work down into the solid material. The relatively high speed of the cutter permits a proportionately fine feed, thus lengthening the life of the cutter. With each machine one cutter is furnished, and one special head fixture for use in indexing heads from which new cutters may be milled. These machines are now made in three sizes, the one shown in Fig. 1 having a table 36½ by 10¼ inches working surface, and feeds, all automatic, 25½ by 5¾ by 17 inches. The machine shown in Fig. 2 has feeds, the vertical being automatic, 7½ by 3 by 8 inches, and a table 18 by 8 inches working surface.

A TWENTY-FOUR INCH BACK-GEARED CRANK SHAPER.

The Queen City Machine Tool Co., Cincinnati, O., have introduced a 24-inch, back-geared crank shaper which is here

illustrated. The design is rigid and powerful, and as the ratio of back gearing is 29 to 1, full benefit may be got out of high-speed steels.

The 16-inch crank shaper of this company was illustrated and described in MACHINERY for October, 1904, and all the novel features of this tool are embodied in the 24-inch design. In both machines the crank is connected to the ram by means of a rocker arm and link, so that the forward cutting stroke

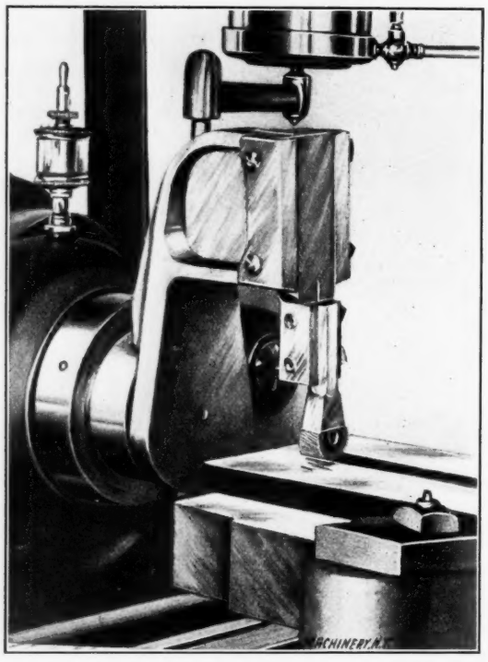
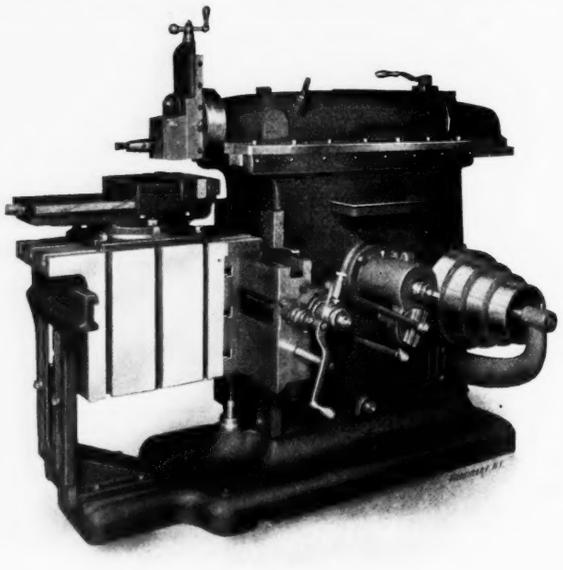


Fig. 4. Oscillating Milling Machine milling a Semi-circular Groove.

is a pull by the crank rather than a push; the ram is so arched as to bring the maximum section of metal into service when the cutting tool is in its extreme forward position. In the description of the 16-inch machine before mentioned, the details of ram, rocker arm, and back gears were illustrated.

In the 24-inch shaper the bearing for the ram is 40x11 inches, and the ways for the ram overhang, especially in

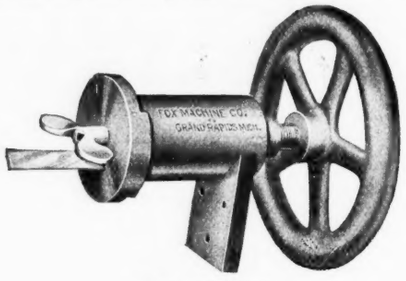


A 24-inch Back-geared Crank Shaper.

front. The rail has a 9-inch front and 1¾-inch top wearing surfaces. The cross traverse is 30 inches and the screw has a graduated collar. A cam at this point provides for a rapid changing of feeds from 0 to the extreme without stopping the machine. A telescopic elevating screw is used. The table is box form, T-slotted on top and sides has a V for holding shafts and similar work vertically; the outer support for the extension table is furnished on all 24-inch machines. The vise, of the planer type, has a base that can be firmly bolted to the table, and the swivel is held to this base by two steel planer head bolts. The head swivel is held in the same manner and both are graduated. The down feed screw to the head is provided with a graduated collar. A large opening under the ram provides for keyseating shafts or similar work, and has keyseating capacity up to 3¾ inches. The table has a vertical traverse of 15 inches and a cross traverse of 30 inches. The ram has 8 speeds; the feed to the head is 7½ inches.

WAX FILLET PRESS.

The fillet press here illustrated, manufactured by the Fox Machine Co., 815-825 N. Front St., Grand Rapids, Mich., is designed for use in the foundry and pattern shop, for conveniently running out wax fillets and wax core vents of different sizes. These are obtained as desired by turning the dial plate so as to bring the hole of proper size in front of the opening



Wax Fillet Press.

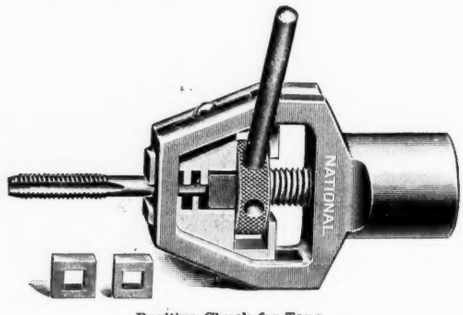
in the cylinder cap. The dial is located inside the cap casting, and may be readily turned by means of the thumbscrew shown. The cap is easily removed for filling the cylinder with wax. The supporting arm of the press is held in a vise when in use.

The press is regularly furnished with one dial for three sizes of core vents, 1-16 inch, 7-64 inch, and 11-64 inch, respectively, also fillets as follows: No. 2, fillet ⅛ inch wide; No. 3, 3-16 inch; No. 4, ¼ inch; No. 6, ⅜ inch, and No. 8, ½ inch wide.

Extra dial plates may be supplied with openings for any sizes of fillets or core vents desired. The press is furnished with a comparatively small handwheel for forcing out the wax. A large wheel may also be furnished if desired for use in cold weather, when the wax becomes so hard that considerable pressure is required; but it is considered better practice to slightly warm the cylinder of the press at such times by holding the press over a gas burner or lamp flame for a few moments, in which case the wax will run out in better shape and a small wheel will then be ample.

POSITIVE CHUCK FOR HOLDING TAPS.

The Oneida National Chuck Co., of Oneida, N. Y., have recently made an adaptation of their drill chuck for the holding of taps positively when tapping or reversing. This is accomplished by cutting out three of the upper teeth in the jaws of



Positive Chuck for Taps.

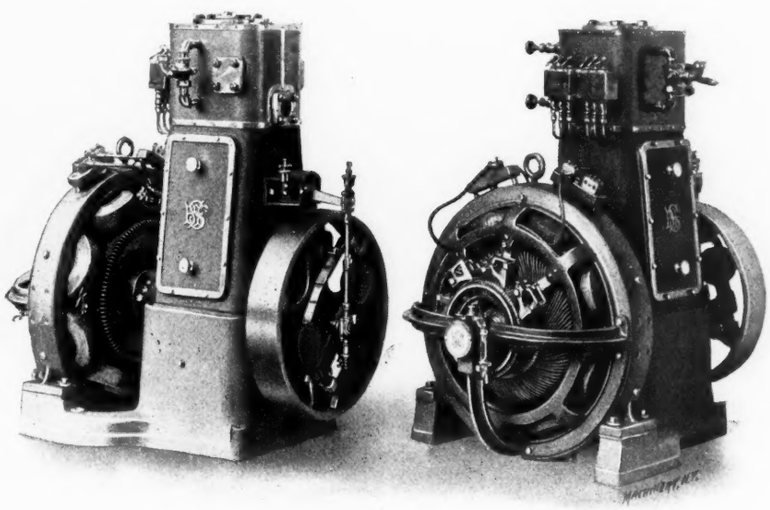
the chuck so as to admit a square block with a square hole into which the square end of the tap is placed; the jaws are then run down upon the tap, the remaining teeth of the jaws gripping the shank, while at the same time the flat part of the jaw grips the side of the square block, thereby holding the tap positively in either direction. The chucks are furnished with a sufficient number of blocks to hold each size of drill up to their full capacity.

A NEW STURTEVANT GENERATING SET.

The B. F. Sturtevant Co., Boston, Mass., have brought out a generating set of a type especially suitable for modern yachts and similar service. It was built originally for the use of the United States government and in accordance with specifications of the Bureau of Equipment.

The engine is of the high-speed reciprocating type designed to run at 650 revolutions per minute. The cylinder, which is cast with the frame, is 4½ inches diameter and 4½ inches stroke. The valve is of the balanced piston type and is operated by a Shepherd governor attached to the flywheel. This governor secures quick action and regulation within 1½ per cent from full load to no load. The piston is secured to the rod by a taper fit; the crosshead, which is of the slipper type with forked-end connecting rod, has a pin 1½ inches in diameter by 1¾ inches long, while the crankpin is 2 inches in diameter by 2½ inches long, and the main bearing is 1 15-16 inches in diameter by 6 inches long. The entire engine is enclosed by a cast-iron frame suitably lagged.

The generator is of the 8-pole type, designed for the continuous output of 5 K.W. at 650 R.P.M. It is capable of carrying for short periods of time 50 per cent overload without shifting of brushes or flashing at the commutator, and is capable of continuous operation at 25 per cent overload without sparking or undue heat. The increase in temperature above that of the surrounding atmosphere will not exceed 40 degrees C. in any of its parts after a continuous run of 10 hours at full load. The insulation resistance is such that it will withstand a breakdown test of 1,500 volts for a period of one minute, and will show a resistance of at least one megohm with an initial voltage of 500.

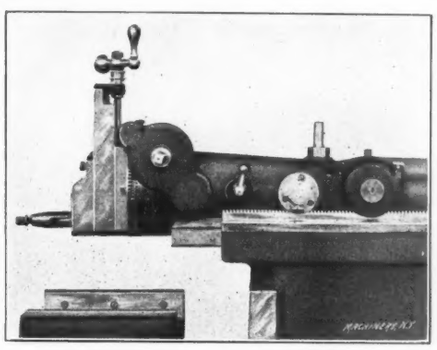


A Sturtevant Generating Set.

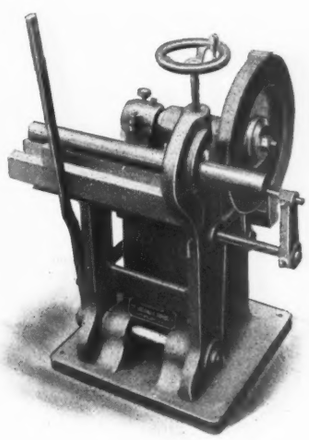
The magnet frame is of cast iron, to which are attached by through bolts the pole pieces of wrought iron with cast-iron shoes. Each pole piece is energized by its own field coils, which are easily removable. The armature is of the iron-clad, two-circuit, form-wound, ventilated drum type, having a core of special low-carbon steel mounted upon a cast-iron spider, which has a hub extension for the support of the commutator. The commutator consists of bars of drawn copper secured in a cast-iron shell of spider construction and clamped with a steel ring. The end insulation consists of micanite rings, and that between the segments is of the best quality mica. The brushes are mounted upon studs which project from a brush rigging attached directly to the magnet frame, and this is so arranged that it may be rotated for adjusting the position of the brushes. The brush holders are of the sliding socket shunt type, each brush being supplied with a flexible connection and having a carrying capacity not exceeding 30 amperes per square inch. The brushes and holders may each be separately adjusted, and are readily removable. The total weight of the set, including the engine, generator, and sub-base, is 1,140 pounds.

AUTOMATIC FEED FOR CRANK SHAPER.

We illustrate herewith an automatic down, angular, and circular feed for a shaper head which the Springfield Machine Tool Co., Springfield, O., have designed, as applied in this instance to their 16-inch back-geared crank shaper. The movement is from the rack, as shown, through a pawl and ratchet and train of gears to the elevating screw, for down and angular, and through a worm and the worm wheel shown, for the circular feed. By the pawl, which is similar to those used on planers, the feed is thrown in or out or reversed. The small lever on the side of the ram between the pawl and gear case to the left of the machine is so arranged that by throwing it from one side to the other the vertical and angular feed will be engaged and the rotary feed disengaged, and *vice versa*. With this lever it is impossible for the circular and vertical feeds to both be engaged at the same time. The small knob shown on the top of the gear case to the extreme right of the illustration is connected with a worm engaging with a worm wheel. This worm wheel has a segmental slot in which two stops are located, one stop being fixed to the friction, the other to the case, which is stationary. By revolving the knob either to the right or the left, the distance between the fixed stop on the case and the movable stop on the friction will either be lengthened or shortened, thus reducing the amount of rotation of the case carrying the feed pawl. A feed variation is thereby formed of from 1 tooth to 24 teeth per stroke. The working parts of the device are all on the right side of the machine. The gears are all thoroughly protected and covered with gear guards and the design presents a very neat appearance.



Shaper Head with Automatic Down and Circular Feed.



A Hot Saw for Drop Forgings.

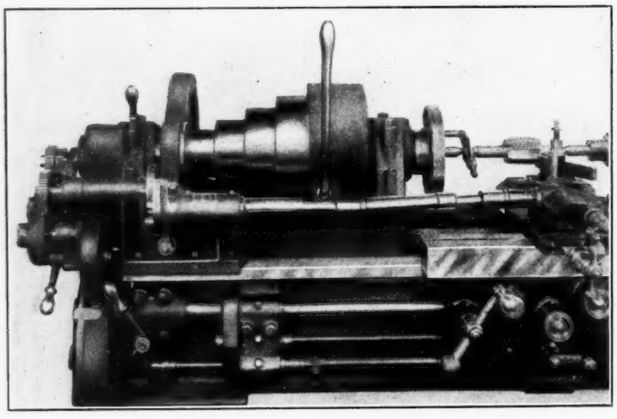
HOT SAW FOR DROP FORGINGS.

The Billings & Spencer Co., Hartford, Conn., have gotten out a hot saw for the rapid cutting of bar stock and the ends of such forgings as crankshafts, spindles, axles, etc. The saw is shown in the accompanying cut which is self-explanatory.

The saw cuts either hot or cold, but a considerable saving of time may be effected in the case of forgings by cutting hot, thus doing away with the necessity for several handlings. The saw is 20 inches in diameter by ⅛-inch in thickness, and has a capacity of 3 inches round iron or soft steel. It takes a 4-inch belt, and is meant to run at 1,900 revolutions.

LATHE RELIEVING ATTACHMENT.

Below is shown a relieving attachment designed by the Springfield Machine Tool Co., Springfield, O., as applied to one of their lathes. It is made for the purpose of accurately backing off the teeth of taps, cutters, mills, hobs, etc., a tap being shown between the centers of the machine in the illustration. Oscillatory motion is given to the flexible shaft leading to the tool slide by a crank carrying the roller in contact with the cam as shown, the cam being driven through a train of gears from a pinion on the end of the spindle; this oscillatory motion giving reciprocating motion to the tool slide



Lathe Relieving Attachment.

through rack and pinion in the slide. The latter fits to the top of the cross slide, and can be set at an angle for backing off end mills, etc. The number of movements per revolution may be changed by varying the change gears, while the amount of each movement, governing the clearance to be given the cutter may be regulated by varying the throw of the crank.

MISCELLANEOUS TOOLS AND APPLIANCES.

L. Robbins, Worcester, Mass., has brought out a new patternmakers' lathe, built in two sizes, 20 and 24 inches. The headstock is swiveled, graduated in degrees, and is provided with a quick-acting cam binder.

A micrometer slide gage made by C. D. Clark, Torrington, Conn., measures by thousandths from 3-16 inch to 1¼ inch without extension pins, and with the latter up to 4¼ inches. It is useful as a sizing block for setting shaper or planer tools.

A turret head applicable to engine lathes and speed lathes is made by the Baker Machine Corporation, New Bedford, Mass. The shank of the head fits over the tail spindle of the lathe. The head is indexed by means of notches on the outside.

The Cincinnati Machine Tool Co., Cincinnati, O., have brought out an upright drill with a positive geared feed. Six changes of feed are obtainable by the movement of the graduated handle on a feed box mounted on the sliding head.

A 5-foot arm radial drill built by the Fosdick Machine Tool Co., Cincinnati, O., has 12 speeds with cone drive, and 18 speeds with a speed box. The arm swings on ball bearings; an automatic trip and a tap attachment are provided. There are 8 changes of feed.

A powerful single pitman, straight-sided press designed for deep stamping of metal up to ⅜ inch in thickness is built by the Toledo Machine & Tool Co., Toledo, O. Its crankshaft is 13 inches at the bearings. The press bed is 38x38 inches, the width between uprights 38 inches, and the stroke 14 inches.

The Espen-Lucas Co., Philadelphia, Pa., have placed on the market a new design of their cold saw cutting-off machine, similar to some of its predecessors, but redesigned so as to be heavier in some of its parts, for the purpose of driving a modern high-speed steel inserted-tooth saw up to its limit. It has cut 6-inch steel bars of 0.25 per cent carbon in six minutes.

A blueprint washing and drying machine has been brought out by C. F. Pease, 172 West Locust street, Columbus, O. With this device the washing of the prints is accomplished by a spray of water flowing over the treated side of the paper only. As the prints are not soaked through, the drying is a matter of but little time. Surplus water is removed from the print by a wiping device.

A large cold saw cutting-off machine adapted for steel foundry work has been designed by the Newton Machine Tool Works, Philadelphia, Pa. The saw is fitted with inserted teeth, and is capable of cutting off gates and risers up to 17 inches cross-sectional diameter. The ram has an automatic feed of 30 inches, the speed of which is varied through the friction disk, and power quick return.

The Willey electrically-driven shop saw has been added to the list of motor-driven tools manufactured by James Clark, Jr., & Co., Louisville, Ky. In this saw the motor is incorporated in the frame of the machine. The saw feeds by gravity and has an automatic stop which releases the switch when the work is cut off. It is designed for 12-inch saw blades, and cuts off stock 4½ inches in diameter.

A 2x26-inch turret lathe with a special equipment for handling a wide variety of work in a locomotive shop has been brought out by the Pratt & Whitney Co., Hartford, Conn. A special taper turner is provided for machining the long taper bolts used in locomotive frames. Another useful adaptation of this lathe is the turning and centering of forged bolts, the heads of which are somewhat eccentric.

A horizontal spindle boring, drilling, and milling machine built by the Newton Machine Tool Works, Philadelphia, Pa., has power feed and quick traverse in three directions. The speed of the 4½-inch spindle is varied by both mechanical and electric means, a main motor of 5 H. P. driving the spindle and the feeds of bar and saddle, while the feed on the base is by a separate motor of 3 H. P.

A quick-acting monkey wrench is made in four sizes from 4 to 15 inches by the Bay State Tool Co., 294 Washington Street, Boston. In this a screw with an interrupted thread, engaging with a similar thread in the jaw, replaces the usual screw and nut. By turning the thumb piece on the screw, the jaw may be slid in or out, and by a further turning of the thumb-piece the jaw may be locked in whatever position it then occupies.

An automatic press having five slides, designed especially for drawing and finishing sheet metal shells where a number of operations are required for finishing, has been gotten out by the Consolidated Press & Tool Co., Chicago, Ill. The shells made on a combination die are placed on a friction dial, a reciprocating feed carrying them thence from one die to another, the discharge being automatic. Such work as oil can tops, lantern parts, stove trimmings, etc., are turned out.

A 30-inch vertical turret boring and turning mill, designed by the Niles-Bement-Pond Co., New York, is particularly intended to use high duty steels. Numerous speeds and feeds are provided, and minor details of design contribute to rapidity of production. In a recent job fifty brass bushings 8¼ inches long and 4½ inches internal diameter were bored in a roughing and finishing cut in five and a quarter hours, the machine running at a cutting speed of 155 feet per minute.

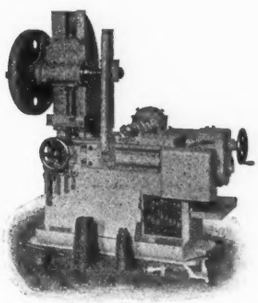
The E. W. Bliss Co., Brooklyn, N. Y., have designed a press for perforating sheet metal whereby a whole sheet can be finished with a single operation. The sheet is clamped on a sliding table which is automatically fed under a slide which carries from one to fifty punches. Automatic feeds and a quick return motion are provided for the table. The machine is arranged to punch two 1-inch holes in ¾-inch iron or the equivalent of this work with smaller holes. The stroke is 2 inches. The ways are 27 feet long and are made to carry plates ¾x60x144 inches.

Something new in emery wheels has been brought out by the Corrugated Grinding Wheel Co., Philadelphia, Pa. The cor-

Brown & Sharpe Mfg. Company

Providence, Rhode Island, U. S. A.

Automatic Gear



Cutting Machines

Nine Sizes

Cutter Spindle. Hardened steel. Powerfully and smoothly driven by worm gearing. Cutter Arbor, large diameter; has hardened sleeve running in outer bearing. Cutter speeds obtained by change gears; speeds in geometrical progression.

Cutter Slide. Return rapid. Operated by independent and constant drive. Ways have large bearing surfaces, narrow in proportion to length; insures maintenance of alignment.

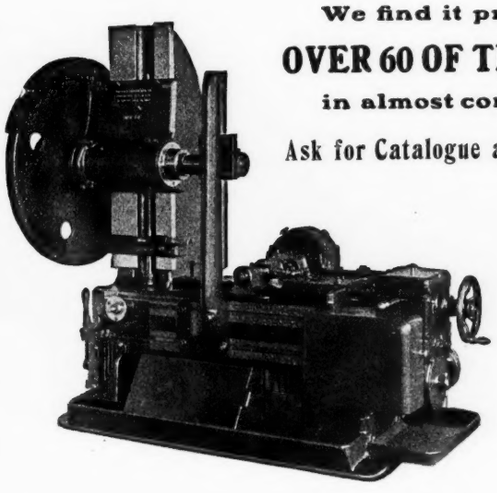
Work Spindle. Large diameter. Rigidly mounted in heavy slide. Graduated dial reads to thousandths for setting to depth of cut.

Indicator. For setting Cutter central by indicating from pitch line. Surface where indicator is placed when setting Cutter retains original accuracy.

Indexing Mechanism. Positive. Operates without shock. Provision for more than one turn of locking disk, relieves mechanism from heavy strain. Large diameter and extreme accuracy of index wheel. Fine adjustment for use in seting to recut a gear.

Feed Mechanism. Driven by screw and worm gearing; gives powerful and smooth drive. Positive clutches. Wide range of feeds in geometrical progression, obtained by change gears.

Conveniences. Indexing Mechanism can be tripped from front of machine. All dogs and operating levers placed at front of machine, easy of access. Chips confined to pan in base. Provision for attaching pump to supply lubricant to Cutters.



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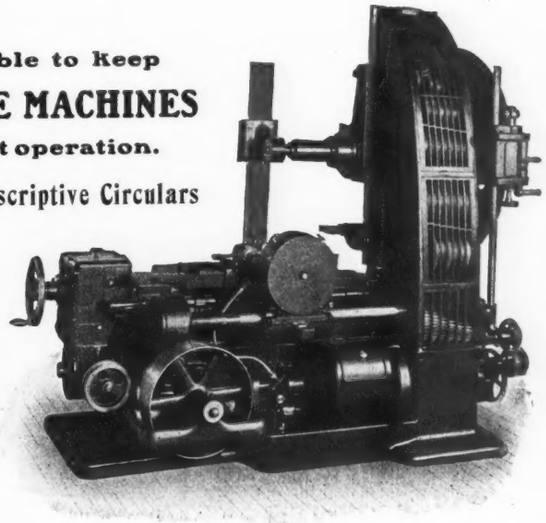

rugations are made across the cutting face of the wheel at an angle, the effect of the corrugation being said to be more rapid grinding with less heating of the work and a less tendency to glaze; hence much harder wheels than usual are made practicable. In a test of the cutting ability of one of these wheels before and after corrugating, a net gain of 140 per cent in time for the same amount of work was said to be obtained by the corrugation.

A heavy, vertical boring machine made by Baker Bros., Toledo, O., for the machining of automobile crank cases is furnished with a special revolving jig. The machine bores and faces one end of the case, after which the chuck holding the work is rotated one-half turn, and the opposite end of the crank case is finished. The chuck is locked in position by taper pins. The two bores of the crank case are not on the same center line, this being provided for in the chuck by having the latter bolted to the column distant from the center line of the spindle one-half the distance between the center lines of the two bores of the crank case.

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FRESH FROM THE PRESS.

THE NORMAN W. HENLEY & SON CO., 132 Nassau Street, New York, have brought out an interesting chart showing a boiler room, including the boiler feed-water heater, feed pump, etc., in isometric projection. Part of the boiler setting and of the boiler itself is broken away, so that all the details are visible and the feed water heater and pump are shown in half section. The boiler is of the water-tube type, with superheater. All the parts of the apparatus are numbered and named in a printed list which has 235 references. The price of the chart is 25 cents.

NOTES ON MECHANICAL DRAWING, INTRODUCTORY TO MACHINE DESIGN, by P. M. Chamberlain, Professor of Mechanical Engineering in Lewis Institute. 68 pages 6 x 9 inches, with 96 cuts. Published by the author at Chicago, Ill. For sale by McClurg & Co., Wabash Avenue, Chicago, Ill. Price, 75 cents.

This collection of notes represents the author's method of teaching mechanical drawing to first-year classes. Most of the problems are purely geometrical, but a few in machine detail are included. A number of useful tables are given at the back.

ELEMENTS OF MECHANICAL DRAWING, by Gardner C. Anthony, Professor of Drawing in Tufts College, etc. 152 pages, 6½ x 7¼ inches, with 196 figures and numerous sketches for problems. Published by D. C. Heath & Co., Boston, Mass. Price, $1.50.

This revised edition of Anthony's well-known work on drawing incorporates some radical changes from the older edition. The folding plates have been abandoned, the illustrations in this edition being printed with the text which obviously is a much more convenient arrangement. Many figures have been added and all have been redrawn. The problems with their sketch layouts are placed at the back of the book.

THE TESTING OF CONTINUOUS CURRENT MACHINES IN LABORATORIES AND TEST ROOMS, by Charles Kinzbrunner, Lecturer on Electrical Engineering and Design at the Municipal School of Technology, Manchester. 336 pages, 5½ x 8½ inches, with 249 illustrations and diagrams. Published by John Wiley & Sons, New York. Price, $2.00.

This work, which originated in the author's written instructions to his students in the Municipal School of Technology, Manchester, is intended for students in technical colleges, and for electrical and mechanical engineers generally who are engaged in testing work or in the installation of electrical machinery. Considering the character of the work and the great mass of matter contained, it is remarkably low-priced as such works go. It should be in the hands of every electrical testing engineer.

ELEMENTS OF MECHANICS, by Mansfield Merriman, Professor of Civil Engineering in Lehigh University. 172 pages, 4¾ x 7¼ inches, with 142 cuts. Published by John Wiley & Sons, New York. Price in cloth binding, $1.00 net.

The author says in his prefatory remarks that, fortunately, the elements of mechanics can be presented without the use of the higher mathematics, and the book in review is an effort in this direction. To study it understandingly a knowledge of plane geometry, elementary algebra and plane trigonometry only are required. Hence it is suitable for the use of manual training schools, and beginners in engineering generally. The chapters treat of the following subjects in the order noted: Concurrent Forces; Parallel Forces; Center of Gravity; Resistance and Work; Simple Machines; Gravity and Motion; Inertia and Motion. A valuable feature of the work is a large number of problems following each article of the different chapters, the working of which gives the necessary mental drill and grasp of the subject that nothing else can. Answers are given in the appendix to all problems, so that the student can verify his work.

THE CYCLOPEDIA OF APPLIED ELECTRICITY. Published by the American School of Correspondence, Armour Institute of Technology, Chicago, Ill. Five volumes and over 3,000 illustrations. Bound in three-quarters red leather. Price for the set $30.

Some time ago the American School of Correspondence brought out a library on modern engineering practice containing several volumes treating of mechanical construction, machine design, shop work, steam engines, boilers, etc. This set of books proved popular and it has now been followed by the "Cyclopedia of Applied Electricity," which is undoubtedly even more complete in its own special field than was the previous set of books. We understand that the contents of the books is substantially the material used by the instructing force of the school, and it is accordingly written in simple language and copiously illustrated. The various articles comprising the series have been written by leading technical writers, including professors of several colleges and other experts. The following is a brief summary of some of the most important features of the volumes:

VOL. I. ELEMENTS OF ELECTRICITY. The first section contains description of the fundamental laws of electricity; the second treats of the electric current and the relations of electromotive force, current and resistance as determined by Ohm's laws; the next of electrical measurements and an explanation of the system of C. G. S. units and other practical units; the next section is devoted to electric wiring and the installation of electrical machinery; the next takes up the electric telegraph, describing the Morse code, etc.

VOL. II. DYNAMO ELECTRIC MACHINERY AND STORAGE BATTERIES. Chapter I explains the theory and fundamental principles of the electric generator; Chapter II deals with direct-current dynamos; Chapter III with the different types of direct-current generators as made by the leading American electrical manufacturers; the next is a discussion of the direct car motor, chiefly a mathematical discussion. A special chapter is devoted to electric motors in machine shop service, and the volume concludes with a section on storage batteries, and their applications to different classes of work.

VOL. III. ELECTRIC LIGHTING, ELECTRIC RAILWAYS AND THE OPERATION OF DYNAMO-ELECTRIC MACHINERY. The following subjects are treated: The manufacture and properties of incandescent lamps; the mechanism of the various types of both direct-current and alternating-current arc lamps; power distribution for the lamps; illumination in public halls, offices, factories; shop lighting, electric railways; power supply and distribution; management of dynamo-electric machinery; power stations; central station engineering, and a brief chapter on "A Graphical Method of Recording Data of Boiler Tests."

VOL. IV. ALTERNATING CURRENTS AND AUTOMATIC CURRENT MACHINERY. The following are considered: The simplest type of alternator; advantages and disadvantages of the use of alternating currents for the transmission of power over long distances; measuring instruments; armature windings for single, double and three-phase machines; alternating current testing; synchromotors and induction motors; transformers; rotary converters; alternating-current calculations of efficiencies, performance curves of motors, etc.; and a chapter devoted to the Hewitt mercury vapor converter.

VOL. V. THE TELEPHONE. Section I takes up sound, primary and storage batteries, the history of the development of the telephone, description of its various parts, with a careful explanation of their action. Section II is devoted to simple open-line work, and carefully explains the setting of the poles, stringing of wires and guying. Section III describes the placing of overhead and underground cables, including testing, causes of cross talk, induction, transpositions and connecting. The use of modern lightning arresters and distributing frames, and the parts of the switchboard, are explained. Section IV gives a method of wiring switchboards. Section V explains common battery work, shows circuits of various systems, together with the trunk lines used with them. Section VI treats of maintenance, explaining the duties of each part of the working force of a telephone system. The automatic telephone system is described and an article on wireless telephony also appears.

NEW TRADE LITERATURE.

THE SPRAGUE ELECTRIC CO., New York City. Bulletin No. 505, treating of the flexible steel-armored hose, described in our March issue.

THE INGERSOLL-SERGEANT DRILL CO., New York. Form 35A, showing some of the different types of their air compressors, and listing their other products.

THE DE LAVAL STEAM TURBINE CO., Trenton, N. J. Catalogue B of the De Laval centrifugal pumps and steam turbines, whose characteristics are here fully described.

THE WASHBURN SHOPS, Worcester, Mass. Catalogue C, 1905, of the Worcester drill grinders, for wet and dry grinding. The different styles are shown and directions given as to their proper use.

THE INGERSOLL-SERGEANT DRILL CO., New York. Bulletin 2000, the first of a series describing labor-saving tools operated by compressed air, treats of the MacDonald rivet forge. The series will be sent to any one interested.

THE NATIONAL MACHINE CO., Hartford, Conn., successors to the Woodward & Rogers Co. Catalogue of sensitive drill presses, of many sizes, belt- and motor-driven; grinders, a centering machine, a horizontal tapping machine, etc.

THE C. W. HUNT CO., West New Brighton, N. Y. Pamphlets Nos. 051 and 052 showing respectively the Hunt industrial railways, and the general line of machinery, for conveying and hoisting and other purposes, which they manufacture.

THE CURTIS & CO. MFG CO., St. Louis, Mo. Illustrated catalogue, 1905, of pneumatic appliances. This describes and illustrates the company's air compressors, air hoists, air elevators and air cranes, and the book will be sent free upon application.

THE KEMPSMITH MFG. CO., Milwaukee, Wis. Loose-leaf catalogue of the Kempsmith milling machines. These are built in 13 sizes, and of the following types: hand, plain, plain with screw feed, plain with rack feed, universal, etc. Each type is here shown, with specifications.

THE JEFFREY MFG. CO., Columbus, O. Bulletin A, showing different views of a plant where their coal and ash handling machinery is installed. Special attention is called to their new "Class A Grab Buckets" of 48 cubic feet capacity for transferring coal from cars to bin or stock pile.

THE COLBURN MACHINE TOOL CO., Franklin, Pa. Pamphlet descriptive of their 53-inch boring and turning mill, which is adapted to a large range of railroad and machine shop work. Two half-tones show a front and a rear view of the mill, and its advantages and special features are here briefly pointed out.

THE WATERBURY BRASS CO., Waterbury, Conn. 1905 catalogue containing a complete list of the stock carried in their Waterbury and Providence warehouses, consisting of brass, copper and German silver in sheets, wire and rods; brass, copper and bronze in seamless and brazed tubing; and small brass wares of all kinds. The catalogue also contains quite a number of useful tables.

THE FOX MACHINE CO., Grand Rapids, Mich. Special catalogue No. 27, March, 1905, of the Fox machinery for wood and metal pattern work. This includes their universal wood trimmers, built in ten sizes and four styles, band saws, saw tables, buzz planer, pattern-makers' wood and gap lathes, etc., etc. The catalogue will be sent free to those interested in this class of machinery.

H. B. UNDERWOOD & CO., Philadelphia, Pa. Catalogue, 1905, of portable tools for railway repair shops. Portable boring bars for various purposes, a portable facing arm, portable valve seat rotary planing machine, locomotive cylinder or dome-facing machine, portable milling machine, portable crankpin turning machine, eccentric mandrel turning machine are among the products illustrated and described.

THE JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. "Graphite" for April. Monthly publication issued to make known the products of the company, which are graphite paint, and graphite in many forms for lubricating purposes. This issue is particularly interesting, containing hitherto unpublished cuts of notable bridges and buildings in different parts of the world, and other interesting information. Sent free upon request.

MANUFACTURERS' NOTES.

THE CROCKER-WHEELER CO., Ampere, N. J., announce the recent sale of four K. V. A. alternating-current generators for the sanitary district of Chicago.

THE DIAMOND DRILL & MACHINE CO., Birdsboro, Pa., owing to many changes in their products, have changed their firm name to the Birdsboro Steel Foundry & Machine Co.

THE STOCKBRIDGE MACHINE CO., Worcester, Mass., have made arrangements with the Niles-Bement-Pond Co., for the sole agency of their shapers in New York, Boston, Chicago and London.

THE DODGE COAL STORAGE CO., New York, have acquired the business of the United Telpherage Co., of New York. Communications